Fiber Optic Operation

Today, the use of fiber optic systems to carry digitized video, voice and data is universal. In business and industry, fiber optics have become the standard for terrestrial transmission of telecommunication information. In military and defense, the need to deliver ever larger amounts of information at faster speeds is the impetus behind a wide range of retrofit and new fiber optic programs. Although still in its infancy, fly-by-light flight control systems may someday replace fly-by-wire systems with cabling which is lighter, smaller and safer. Fiber optics, combined with satellite and other broadcast media, represents the "new world order" for both commercial telecommunications as well as specialized applications in avionics, robotics, weapon systems, sensors, and transportation.

Functionally, fiber optic systems are similar to the copper wire systems they are rapidly replacing. The principle difference is that fiber optics uses light pulses (photons) to transmit data down fiber lines, instead of electronic pulses to transmit data down copper lines. Other differences are best understood by taking a look at the flow of data from point to point in a fiber optic system.

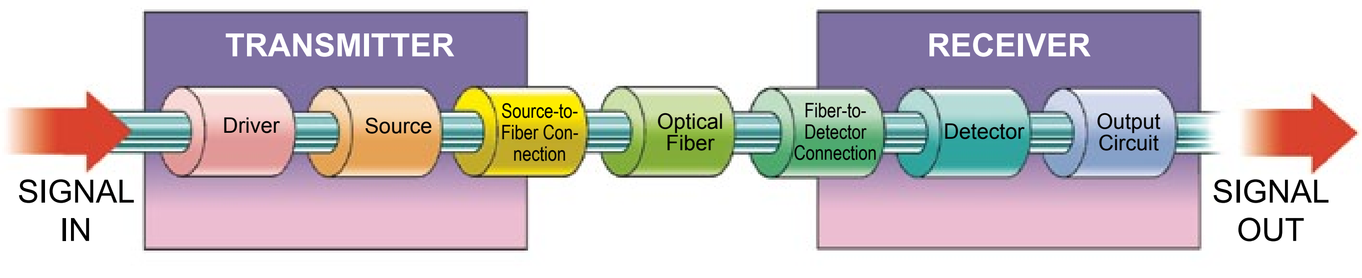
The "encoding" side of an optical communication system is called the transmitter. This is the place of origin for all data entering the fiber optic system. The transmitter essentially converts coded electrical signals into equivalently coded light pulses. A light-emitting diode (LED) or an injection-laser diode (ILD) is typically the source of the actual light pulses. Using a lens, the light pulses are funneled into the fiber optic connector (or terminus), and transmitted down the line.

Light pulses move easily down the fiber optic line because of the principle of "total internal reflection," which basically holds that whenever the angle of incidence exceeds a certain value, light will not emit through the reflective surface of the material, but will bounce back in. In the case of optical communications systems, this principle makes it possible to transmit light pulses down a twisting and turning fiber without losing the light out the sides of the strand.

At the opposite end of the line, the light pulses are channelled into the "decoding" element in the system, known as the optical receiver or detector. Again, the actual fiber to detector connection is accomplished with a specialized fiber optic connector/terminus. The purpose of an optical receiver is to detect the received light incident on it and to convert it to an electrical signal containing the information impressed on the light at the transmitting end. The information is then ready for input into electronic based devices, such as computers, navigation control systems, video monitors and so on.

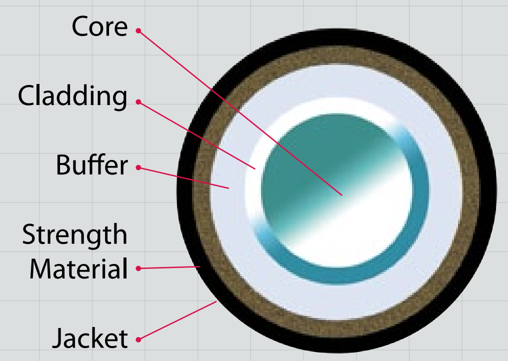
Cable Construction

There are typically five elements that make up the construction of a fiber optic cable: the optic core, optic cladding, buffer, strength member and outer jacket. The optic core is the light-carrying element at the center of the optical fiber. It is commonly made from a combination of highly purified silica and germania. Surrounding the core is the optic cladding made of pure silica. The combination of these materials makes the principle of total internal



Basic Fiber Optic Link

Fiber Optic Cable Cross Section



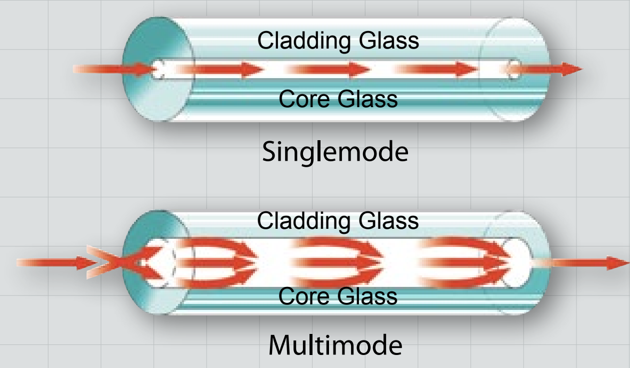
reflection possible, as the difference in materials used in the core and the cladding creates an extremely reflective surface at the point where they interface. Light pulses entering the fiber core reflect off the core/cladding interface and thus remain within the core as they move down the line.

Surrounding the cladding is a buffer material which acts as a shock absorber to protect the core and cladding from damage. A strength member, typically Aramid, surrounds the buffer adding critical tensile strength to the cable to prevent damage from pull forces during installation. The outer jacket protects against abrasion and environmental damage. The type of jacket used also defines the cable's duty and flammability rating.

Rays of light passing through a fiber do not travel randomly. Rather, they are channeled into modes—the thousands of possible paths a light ray may take as it travels down the fiber. A fiber can support as few as one mode and as many as tens of thousands. The number of modes in a fiber is significant because it helps determine the fiber's bandwidth. Multimode fiber has a much larger core than singlemode fiber, allowing hundreds of rays of light to propagate through the fiber simultaneously. Singlemode fiber has a much smaller core, allowing only one mode of light to propagate through the core. Paradoxically, the higher the number of modes, the lower the bandwidth of the cable. The reason is dispersion.

"Modal" dispersion is caused by the different path lengths followed by light rays as they bounce down the fiber (some rays follow a more direct route down the middle of the fiber, and so arrive at their destination well before those rays which waste their time bouncing back and forth against the sides). "Material" dispersion occurs when different wavelengths of light travel at different speeds. By reducing the number of possible modes, you reduce modal dispersion. By limiting the number of wavelengths of light, you reduce material dispersion.

Core Diameters and Their Effect on Modal Dispersion



Singlemode fibers are manufactured with the smallest core size (approximately 8 - 10 um in diameter) and so they eliminate modal dispersion by forcing the light pulses to follow a single, direct path. The bandwidth of a singlemode fiber so far surpasses the capabilities of multimode fiber that its information-carrying capacity is essentially infinite. Singlemode fiber is thus the preferred medium for long distance and high bandwidth applications.

Multimode fiber is generally chosen for applications where bandwidth requirements fall below 600 MHz. Multimode fiber is also ideally suited for short distance applications such as interconnect assemblies used within a single premise or contained space. Because of its larger size, multimode fiber is easier to polish and clean than singlemode, a critical concern in interconnect applications which expose the polished ends of the fibers to debris during connector mating and unmating.

Military Standards

The layout and configuration of a fiber optic system can vary widely based on the application environment. Commercial telecommunications systems, for example, typically feature extremely long backbone cables, spliced fiber interstices, and inexpensive ST type connectors at the many termination points in the system. The connectors used in such applications are typically commodity solutions geared to the low to moderate performance and reliability requirements of that industry. At the other end of the spectrum, fiber optics deployed in military avionics take the form of highly engineered interconnect harnesses and/or multi branch conduit systems. The connectors used in such applications accommodate multiple fiber optic cables and typically utilize precision contacts, or termini, as the primary mechanism for aligning and connecting the optical fibers.

In many such aerospace applications, fiber optics are being employed as replacements or upgrades to existing copper conductor cable harnesses servicing existing black-box flight deck equipment, weapon systems, surveillance cameras, sensors, and so on. In all applications of this caliber, the new fiber optic system must adhere to the same rigorous qualification standards and performance requirements that applied to the legacy electrical systems.

For this reason, the design, configuration and packaging of fiber optic interconnects has closely mirrored existing military standards, such as those covering interconnect mateability, accessory interface dimensions, material finishes, and so on. The design of fiber optic termini, special purpose backshells and other accessories is similarly controlled by existing packaging requirements and interconnect industry dimensional standards.

High-Reliability Connectors

Glenair's High-reliability fiber optic connectors, such as our D38999 style products, are built to ensure precise optical alignment of optical fibers. Connector polarization keys, keyways and optical cavities are manufactured to tighter tolerances than required by general commercial specifications to reduce radial misalignment and insertion loss.

Such connectors also have a bottoming surface design for reliable shell-to-shell bottoming. This ensures the linear dimensional relationship of the contact termini are the same after each connector mating because the connector effectively seats at a predetermined location each and every time. This location, or datum surface, provides a reference location back to the terminus retention clip. The pin and socket location is dimensioned from this stable bottom to acheive a repeatable and reliable connection. Conductive surface plating ensures EMI/RFI penetration into the electronics equipment area is effectively cut off. Precision molded shells and insulators provide closely controlled dimensions with little variability from one part to the next.

Fiber Optic Interconnect Termini

Fiber optic connectors are designed to be connected and disconnected many times without affecting the optical performance of the fiber circuit. Connectors can be thought of as transition devices which make it possible to divide fiber optic networks into interconnected subsystems and to facilitate the attachment of individual branches of the system to a transmitter, receiver or another fiber. The MIL-DTL-38999 connector is currently the most commonly specified multi-pin cylindrical interconnect in both fiber and copper conductor aerospace applications. When used to connect multiple strands of fiber simultaneously, the D38999 connector functions as a container or shell for the precision termini which perform the actual marriage of the fiber strands.

Over the past two decades there have been dramatic tolerance improvements in terminus design to ensure precise, repeatable, axial and angular alignment between pin and socket termini within the connector shell. Ferrule design, critical to the performance of

Fiber Optic Terminology:

Attenuation

Loss or decrease in power from one point to another in a fiber optic cable.

Bandwidth

The information carrying capacity of an optical fiber, expressed in MHz/km. The measure is dependent upon wavelength and type of light source.

Attenuation Limited Operation

The condition in a fiber optic link when operation is limited by the power of the received signal (rather than by bandwidth or by distortion). Attenuation is usually measured in decibels per kilometer (db/km) at a specific wavelength. The lower the number, the better the fiber.

Bandwidth Limited Operation

The condition prevailing when the system bandwidth, rather than the amplitude of the signal, limits performance. The condition is reached when modal dispersion distorts the shape of the waveform beyond specified limits.

Bend Radius

Radius a fiber or fiber optic cable can bend before breaking or suffering increased attenuation.

Decibel (dB)

Unit for measuring the relative strength of a signal. The same unit is utilized to measure insertion loss.

the termini, has traditionally relied on a machined stainless steel ferrule incorporating a precision micro-drilled hole. Glenair's fiber optic termini for D38999 Series III connectors are qualified to MIL-PRF-29504/4 and /5 requirements. 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. Glenair's ferrules are approximately 10 times more accurate than alternative designs, and have reduced insertion loss values from 1.5dB to less than .5dB.

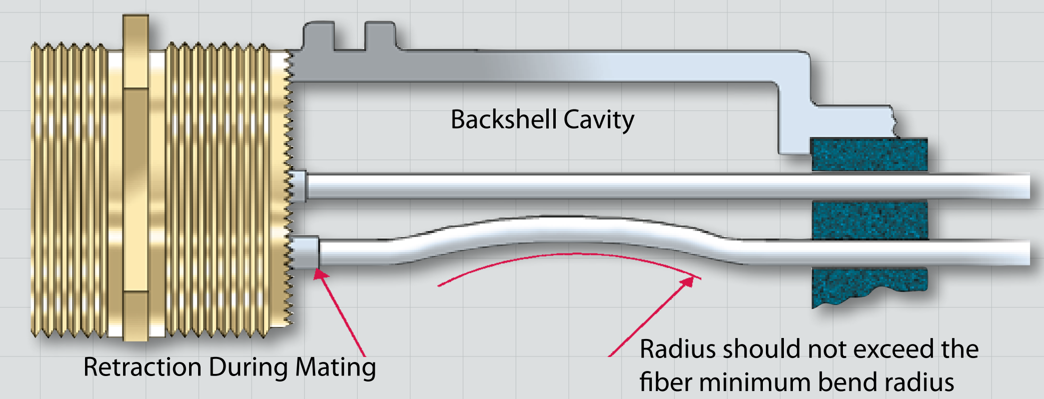
Glenair custom single and multichannel fiber optic connectors utilize the latest composite thermoplastic materials technology and are designed for use with Glenair's family of fiber optic connector accessories.

Fiber Optic Backshells

Fiber optic strands are robust and reliable. But they may not be manhandled (clamped, bent, or crushed) with the same vigor one might employ when working with a fat copper conductor. For this reason, fiber optic connector and cable accessories are designed to reduce bending and to eliminate compression forces. Needless to say, conventional connector backshells such as cable clamps and strain reliefs which apply compression forces directly to the cable, are not appropriate for use in fiber optic assemblies. Likewise, accessory elbows, conduit transitions, and other fittings which subject fiber optic cables to abrupt changes in direction beyond the acceptable bend radius of the fiber are equally risky. In both cases, the dangers are either outright breakage of the fiber optic core or attenuation of the optical signal.

Glenair's composite thermoplastic fiber optic accessories—including elbows, transitions and end-bells—are designed with smooth 45° or 90° bends to insure the non-abrupt routing of the cable. Composite Qwik-Clamps and heat shrinkable boots provide strain relief without applying severe compression to the cable. Glenair's cable overmolding capability enables the integration of unique straight or angular shapes directly into the

Termini Retraction and Its Effect On Micro-Bending



cable to insure the best possible fiber position and alignment.

Glenair's FiberCon® Backshells are specifically designed to meet the unique requirements of the media. For both single fiber leads as well as multichannel applications, FiberCon® provide full support and vibration dampening while allowing the fiber to "float" as required to eliminate micro-bending. Fiber optic terminations differ from electrical in one critical way: during connector mating the fiber optic spring-loaded socket or pin retracts from .040 to .080 inches. It is critical that the backshell design accommodates this movement within the shell cavity to prevent data loss due to micro bending which leads to localized light refraction. The unique rubber support grommet utilized in Glenair's design employs the same layout pattern as the connector shell—providing both necessary axial alignment, as well as strain relief and float.

Fiber Optic Costs and Benefits

When evaluating the costs and benefits of moving to fiber, it is important to adopt both a short and long term view. In the short term, it is arguably less expensive to simply continue using copper cabling to meet an incremental expansion of data communication needs. This avoids the expense of adding the transmitters, converters, repeaters, connectors, termini, receivers and so on needed for integrating optical fiber into an existing electronic system.

(Continued from Page M-4)

Fiber Optic Terminology:

Ferrule

A small alignment tube attached to the end of the fiber and used in connector termini. Generally made of stainless steel, ceramics, or zirconia, the ferrule is used to confine and align the stripped end of the fiber.

Fresnel Reflection Loss

Reflection losses incurred at the input and output points of optical fibers due to the difference in refractive index between core glass and immersion media.

Insertion Loss

Attenuation caused by the insertion of an optical component; in other words, a connector terminus or coupler in an optical transmission system.

Light

In the laser and optical communication fields, the portion of the electromagnetic spectrum that can be handled by the basic optical techniques used for the visible spectrum.

(Continued from Page M-5)

Fiber Optic Terminology:

Misalignment Loss

The loss of power resulting from axial misalignment, lateral displacement, and end separation.

Optical Time Domain Reflectometer (OTDR)

Testing system for fiber strands in which an optical pulse is transmitted through the fiber and the resulting backscatter and reflections are used to estimate attenuation and identify defects and the sources of localized losses.

Source

The means used to convert an electrical information carrying signal to a corresponding optical signal for transmission by fiber. The source is usually a Light Emitting Diode (LED) or Laser.

Transceiver

An electronic device which has both transmit and receive capabilities.

Transducer

A device for converting energy from one form to another, such as optical energy to electrical energy.

Transmission Loss

Total loss encountered in transmission through a system.

Transmitter

An electronic package which converts an electrical signal to an optical signal.

Taking the long view, investing in the conversion to fiber optics often makes good sense, especially given the performance benefits—EMI immunity, security, weight reduction, bandwidth, etc.—as well as cost of-ownership factors such as reduced cable maintenance costs and ease of installation. The ability to more easily accommodate future bandwidth requirements as well as the ability to incorporate redundant fibers for improved safety and reliability further reduces the long-term cost-of ownership. Glenair has worked closely with engineers on a broad range of programs—from the F-22 to the RAH-66 Helicopter—to analyze system requirements and to design high-reliability fiber optic solutions that meet both short and long term cost requirements, and the life-cycle projections for the application.

Fiber Optic Connector and Cable Packaging

The packaging and layout of a fiber optic interconnect assembly can vary widely depending on the application environment. Fiber optics deployed in military avionics, for example, may take the form of a simplex pigtail connector assembly when fiber is used to interconnect the optical transmitter/receiver inside an equipment enclosure to the outside world via a panel mounted receptacle connector or feed through adapter (see picture, opposite page). Rugged, environmental applications, such as a weapon interconnect cable intersecting a fuel tank may require more ruggedized cable construction. Long-run, point-to-point fiber optic cabling in battlefield or secure bunker applications are typically cabled in spools with hermaphroditic connectors.

Specialized interconnect technologies, including unique backshells, conduit transitions, fiber alignment grommets and so on are regularly employed by Glenair to ensure the fiber optic media is protected from environmental and physical damage, and meets the installation and repairability requirements of the application. The following guide to fiber optic interconnect packaging provides an overview of the most common layouts used in high-reliability applications:

Packaging Solutions for Inside the Box

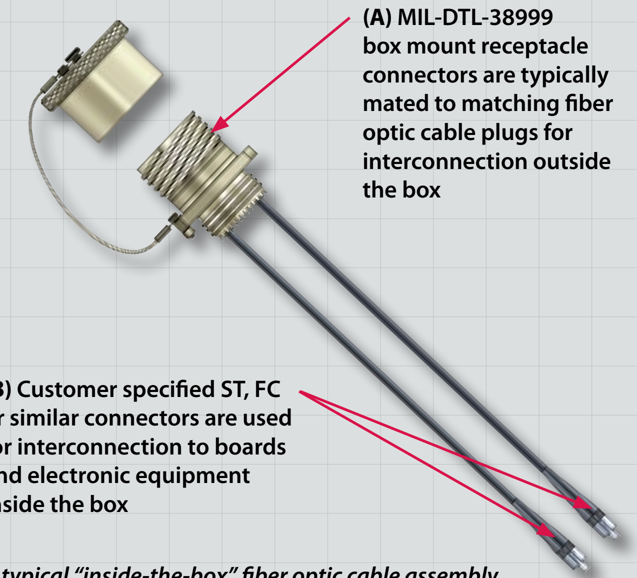
When fiber leads are used within equipment enclosures or other protected environments, the interconnect assembly generally looks something like the figure below: a wall mount or jam nut mount receptacle connector ("A") with simplex fiber leads. This receptacle connector is used to penetrate the enclosure and mate to the external environmental plug connector.

The simplex leads within the protected enclosure commonly route to the transceiver optical device, and are terminated to common commercial connectors such as ST, FC, SC, LC (or other) connectors at the "B" end.

Glenair can also supply pigtail assemblies of this type with a FiberCon® backshell and/or a protective length of conduit. This design approach ensures strict alignment of the fiber strands to the connector, optimum strain relief to the individual fibers as well as crush protection.

The use of a short length of conduit and a small end-bell fitting is recommended in applications where a heat or abrasion source within the box may damage the fiber media. In most cases, analysis of the available space is critical to ensure such interconnect hardware does not interfere with the electronics package inside the box. This basic packaging is appropriate for any equipment—such as a radar, camera, shipboard console, antenna and so on—with an internal fiber wire servicing an optical transmitter/receiver.

Glenair can supply the complete interconnect assembly, including the connector, termini, fiber, optional backshell fittings and conduit. Glenair's ASAP Fiber Optic Cable Sets are specifically designed for applications of this type.



A typical "inside-the-box" fiber optic cable assembly. Cables of this type are now available as a standard short-lead catalog product from Glenair.

Packaging Solutions for External Point to Point Applications

While inside-the-box applications may be conveniently terminated in the field during the installation of the electronic equipment, other fiber optic interconnect cables lend themselves to factory termination and assembly. This is due to the rugged nature of the environments in which they are used. When fiber optic cables need to withstand rough handling, caustic and corrosive fluids or other sources of physical or environmental stress, the interconnect package needs to be extremely tough, and the cables are generally factory-terminated with the appropriate protective materials. Factory assembly is also called for when there are no restrictions or impediments to providing a pre-built harness or assembly, such as unpredictable distances between bulkheads or other site-specific routing problems. Factory-terminated fiber optic cables are typically multichannel, with sometimes as many as 30 fiber optic channels. Examples include ship-to-shore phone/data cables, fuel cell cable harnesses, intra-car railway cables, and other harsh environmental applications.

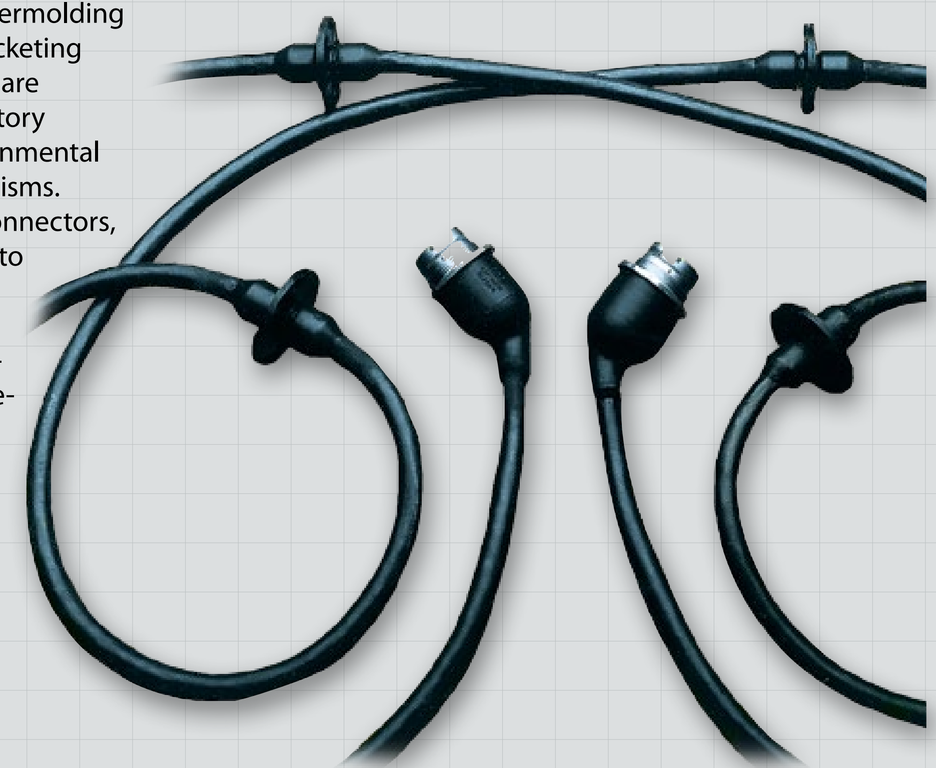
The range of performance requirements for rugged, external cables includes strain-relief, environmental sealing, high tensile pull, crush resistance and chemical resistance. Electromagnetic shielding can also be a requirement in hybrid copper/fiber cables. Packaging generally takes three forms: (1) Overmolded cable harnesses, (2) Metal-core or polymer-core conduit assemblies, and (3) Armored cable equipped with environmental and/or shield terminating backshells.

Overmolded Harnesses

Overmolded designs are specified when field repairability is not an anticipated requirement and harsh environmental and mechanical stress conditions warrant extra protection of the fiber media and terminations. Overmolding technology employs specialized tooling to construct ruggedized, sealed transitions between the cable and the connector and any transition hardware. Overmolding is ideally suited for complex multi-leg harnesses because the many transitions are otherwise difficult to seal with conventional shrink-boots. Overmolding typically uses environmentally resistant jacketing such as Polyurethane. Overmolded cables are extremely rugged and can protect the factory terminations from a broad range of environmental and mechanical stress generation mechanisms. Glenair can integrate its own fiber optic connectors, backshell accessories, termini and cable into such cables—providing a complete, turnkey system. Glenair also offers point-to-point overmolded cable sets with plug-to-plug, plug-to-receptacle and receptacle-to-receptacle connectors as a standard catalog offering. And because termini-retraction is a critical requirement of MIL-DTL-38999 type connectors, Glenair's unique fiber-optic backshells which facilitate termini retraction and eliminate micro-bending are a critical component in every overmolded cable.

Conduit Assemblies

Conduit is a perfect material for the protection of fiber optic media and for the construction of factory-terminated assemblies. As a wire protection material, conduit has a number of unique advantages over other packaging, such as armored cable and even overmolding. First and foremost, conduit systems offer greater flexibility than other ruggedized designs. This is critical in applications such as intra-car railway data transmission lines where the ability of the harness to flex and bend with the repetitive motion of the rail car is a critical requirement. Conduit is also known for its excellent pull strength, high crush resistance, and relative light weight. Perhaps most important, conduit fittings and transitions can more easily be opened for repair or to expand the number of fiber lines. Additionally, conduit assemblies make use of a wide range of existing fittings and transitions, including lightweight composite versions, to meet virtually any configuration and lay-up requirement.



Glenair high-temperature overmolded cable assemblies are ideally suited for fiber optic and hybrid fiber/copper applications in exposed, harsh environments. Overmolding of fiber is a unique Glenair strength, and has been utilized as a packaging solution in such diverse applications as fighter jet fuel-cell cables and roof-top telecommunication cabling.

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Conduit provides an ideal packaging media for fiber optic cables. The material is highly flexible and can be terminated at the factory with a wide range of shielding, jacketing and other specialized materials. Conduit may be opened for maintenance and repair or to expand the number of lines.

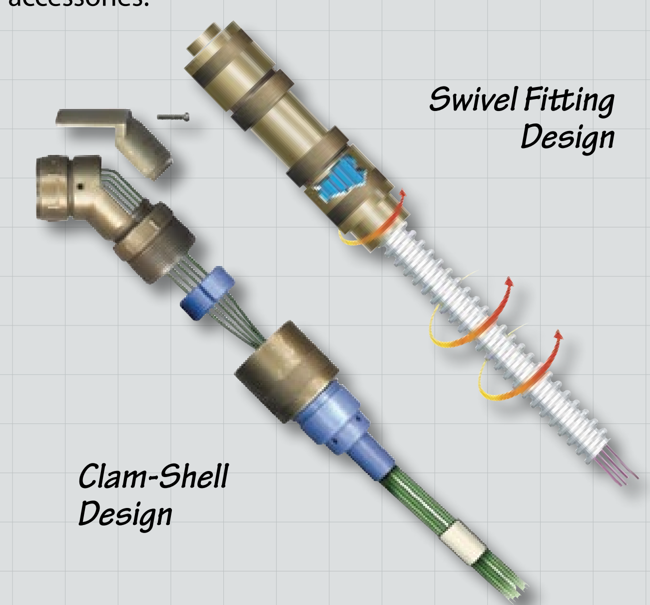
Glenair offers complete in-house capabilities for the construction of fiber optic conduit assemblies. In addition to helically molded polymer materials, we also offer a metal-core conduit product which provides unmatched crush-resistance and EMI protection (for hybrid copper/fiber applications). Both styles of tubing may be outfitted at the factory with braided shielding and external jacketing, or supplied as discrete components for customer assembly. Glenair manufactures all the necessary branched transitions and fittings for every connector and/or feed through configuration.

Reinforced Cable/Backshell Assemblies

Reinforced extruded cable provides a third packaging option for rugged application environments. Multichannel fiber optic cable is available in a broad range of designs. Depending on customer requirements for fiber type, strength members, jacketing material and other component-level options.

Glenair can extrude short-run fiber optic cable for most high-performance applications. The cable becomes the backbone of this packaging solution. A ruggedized, environmental backshell is an equally key component in the armored cable assembly. Such backshells allow for the termination of overall shielding, the provision of additional strain-relief and/or environmental protection of the cable to connector transition.

But the most important design consideration behind the use of such specialized backshells is the ability to provide some level of repairability to the assembly. Unlike overmolded solutions, the reinforced extruded cable/backshell package allows maintenance technicians to open the cable for field service. Backshells are selected for functionality (strain-relief, shield termination, and so on) and for compatibility with the chosen connector. Glenair is able to provide turnkey assemblies of this type as well as all the discrete components—from the extruded cable to the backshells, connectors, termini, dust-caps and other fiber optic interconnect accessories.



The fiber optic backshell pictured above on the left features a unique "clam shell" opening, as well as a tensioning device to prevent overtightening of the backshell clamp. The assembly pictured on the right features a unique swivel fitting to prevent cable torque from affecting fiber alignment. Both are suited for use with standard extruded cable or conduit.

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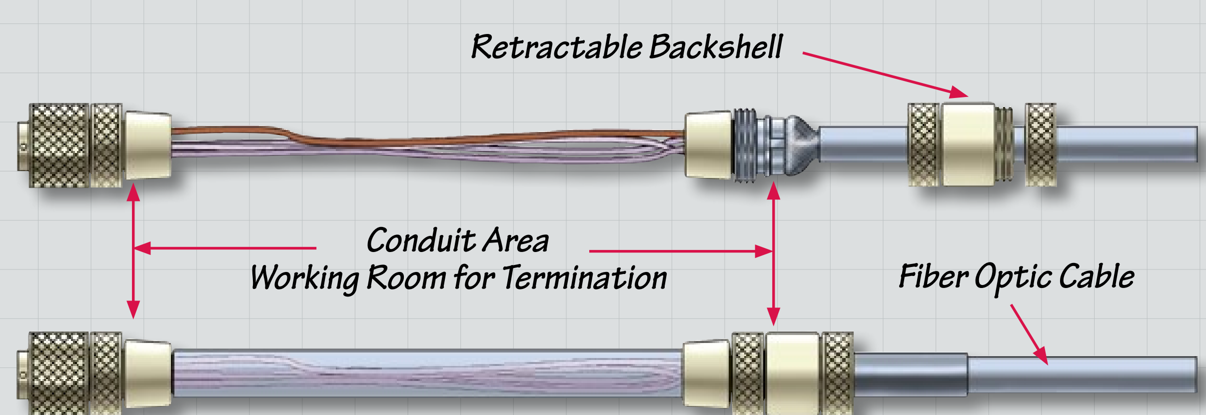
Packaging Solutions for Field Termination

The third major packaging category for fiber optic interconnect applications covers those situations in which a pre-assembled cable or harness cannot be used due to the difficulty of cable installation and routing. A classic example is found in shipboard installation, where the fiber optic cable often has to travel a great distance between the various equipment components in the system. A below-deck control room, for example, may rely on sensors or communications equipment located on the mast of the ship. Between these two elements lies a complicated maze of deck-plating, impenetrable bulkheads and kick-pipes.

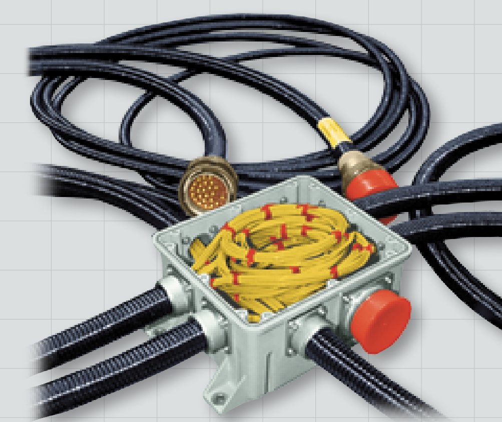
Obviously, it would be impossible to install a factory-terminated assembly into this maze of holes and walls. So, long (trunk) cable runs are completed from point "A" to point "B" and the termination of the fiber optic connector is completed on site at each end of the cable. The challenge is to provide technicians with the ability to strip back an adequate length of the cable to complete the individual fiber line terminations as well as some subsequent way to protect the stripped- back cable from environmental damage.

One solution to the problem is to mount a junction box at each end of the system and bring the trunk cable into the box for subsequent termination of the contacts and protection of the media. Such junction boxes also aid in the routing and storage of the fiber leads. The boxes may be positioned in a centralized location to provide service to multiple pieces of electronic equipment. Additionally, long lengths of stripped cable can be sealed away in the box for subsequent repair and maintenance. Typical box configurations feature either convoluted tubing and environmental feed-through fittings, or in-line and box-mounted fiber optic connectors. Glenair is uniquely positioned to provide integrated fiber optic cable junction boxes of this type. Our line of CostSaver Composite Junction Boxes are specifically designed for use in harsh EMI and environmental applications where field termination of fiber media is a difficult and cumbersome operation.

Glenair's background in providing fiber optic interconnect solutions for the navy has led to the development of some completely unique solutions for the field termination of fiber. Glenair offers a unique backshell and conduit assembly that perfectly suits this requirement. As the illustration below depicts, the Glenair retractable backshell and conduit assembly provides all the working room necessary for easy field termination of fiber.



FIBER OPTIC APPLICATION EXAMPLES



Interconnect Junction and Media Storage

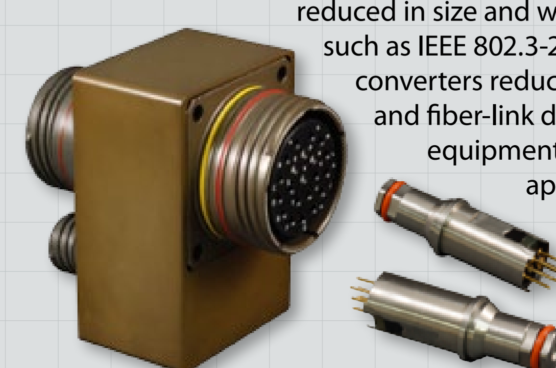
In this application, Glenair was able to provide a complete, turnkey interconnect assembly which included both the light-weight composite junction box, as well as the conduit, fittings, fiber optic connectors and termini. Termination and test of the fiber media and installation of all fittings was completed at the factory to ensure quality and to facilitate fast installation in the field. The box doubles as an environmentally controlled storage area for additional lengths of fiber-optic cable. In the event a termination is damaged, both the conduit and box may be opened to access the termini and the wire-loops for easy repair.

Fly-by-Light

Front-line aircraft are now integrating fiber optic media into their avionic and flight control systems. Glenair's CostSaver Composite Boxes are being used as interconnect junction boxes in fiber optic systems, and as instrument cases in high-speed fiber optic data systems. The innovative products, including composite MIL-DTL-38999 type Series III Connectors, MIL-PRF-29504 qualified termini, Glenair extruded fiber optic cable, as well as feed-through fittings and adapters are all chosen for their ability to reduce the size and weight of the interconnect package while improving the safety, reliability and performance of the flight control system.

Reduced Form Factor Copper to Fiber Media Conversion

The broad utilization of fiber optics in airframe applications, such as for in-flight entertainment and other complex electrical/optical interconnect systems, currently demands transmitter and receiver solutions that are reduced in size and weight. Designed for use in protocol-specific appliation environments such as IEEE 802.3-2005 GB Ethernet, these small form-factor copper-to-fiber media converters reduce weight and complexity while still meeting shock, vibration, and fiber-link distance requirements of traditional F/O transmitter/receiver equipment. In addition to 100BASE-T and DVI compliant converters, many IFE applications are able to utilize optoelectronic contacts in transmitter and receiver roles directly incorporated into ARINC 801 and other standard airframe connector packages. These ultra-lightweight transmitter/receivers are designed for the rigors of in-cabin use and multiple electrical to fiber optic junctions. The technology supports GB Ethernet, AFDX, Fibre Channel, DVI, HDMI and more.



Fiber optic systems carrying digitized video, voice and data continue to multiply. High-speed fiber optic interconnect technologies enable specialized applications in avionics, robotics, weapon systems, sensors, space and other high performance environments. Precision-engineered fiber optic contacts, or termini, are the key to delivering low data loss and reliable, repeatable performance in fiber optic connection systems.

The advantages of a connection system that can transmit the equivalent of 24,000 telephone calls simultaneously through fibers thinner than a human hair go beyond this mind-boggling data transmission rate. Fiber optic systems save size and weight, are immune to EMI interference, are electrically isolated for spark-free performance, and transmit signals that are nearly impossible to intercept for enhanced security.

The challenge for many fiber optic applications is environmental. With data transmitting through a fiber core only 9.3 microns in diameter, a single speck of dust on a conventional butt-joint contact terminus could completely disrupt transmission. This might not be a problem in a controlled, sealed environment—but a military communication shelter rapidly deployed in a windy desert, or a metropolitan commuter train speeding down a gritty, snow-covered track present less than ideal environments for fiber optic operation.

The revolutionary Glenair Eye Beam™ Expanded Beam Fiber Optic Terminus addresses these environmental challenges and delivers enhanced performance to fiber optic interconnect systems. Join us as we explore the use of the Eye-Beam™ fiber optic termini in exciting and emerging fields.

The Eye-Beam™ Lens Terminus Advantage

The Glenair Eye-Beam™ fiber optic terminus is a graded index lens-equipped, expanded-beam optical transmission system. It delivers outstanding performance in challenging environments and eliminates maintenance cycles. The low insertion loss Eye-Beam™ offers comparable performance to standard butt joint termini in a package that's built to withstand rugged use and frequent mating/de-mating in field conditions.

The Glenair Eye-Beam™ contact utilizes an innovative free-floating expanded beam lens and ultra-high precision ceramic alignment sleeves as well as custom designed nickel alloy terminus bodies to ensure perfect axial alignment and optimal optical performance. Best of all, the Eye-Beam™ can be integrated into virtually any circular or rectangular connector package.

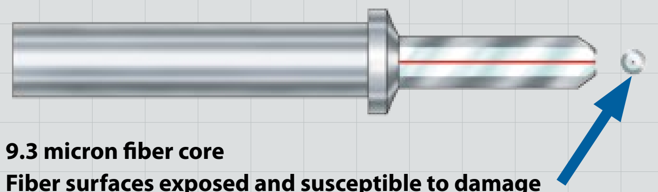
Tactical Field Deployment

Mobile Tactical Shelters are an integral part of Army and Marine battlefield communication systems. These mobile, rapidly deployable shelters provide a vital communication capability. Voice over IP (VoIP) technology allows voice, video and data to be consolidated into one fiber cable system, greatly simplifying deployment. The fiber optic interconnect system for these shelters must be reliable in extreme environments, and able to stand up to rapid mating and de-mating in the field.

Rapid "Daisy-Chaining" of Tactical Fiber Cables

Tactical military applications rely on rapid, trouble-free deployment of interconnect cabling. Glenair GFOCA hermaphroditic expanded beam

Butt-Joint Fiber Optic Terminus



9.3 micron fiber core
Fiber surfaces exposed and susceptible to damage
Must be cleaned prior to mating

Eye-Beam™ Expanded Beam Fiber Optic Terminus

9.3 micron core expanded 27X
Fiber surfaces protected from contamination
Easy clean lens surface

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Main Photo: Command and control specialists work inside a Mobile Air Reporting Communications shelter at Camp Marmal, Afghanistan. The MARC is an air-deployable mobile tactical shelter that provides CRW Airmen with the ability to communicate with aircraft as well as schedule and track cargo movements worldwide. Inset Photos: Mobile tactical shelter specialists installing rooftop antennae, working inside a shelter, and checking communications equipment.

connectors and cables are the perfect solution for frequent mating and unmating of fiber optic cabling in harsh application environments. The sealed Eye-Beam™ expanded beam interface prevents contamination of the optical path, while the hermaphroditic coupling provides operational flexibility and cost savings. Glenair offers both discrete connectors as well custom cable assemblies and field-ready spooled cable sets.

Extreme Harsh Environments

Rail system interconnect design presents many challenges. Reducing weight is a critical issue in high-speed and Maglev rail systems. Shielding electromagnetic interference is also important, especially in sensitive electronic systems such as engine monitoring and diagnostic sensors. Basic mechanical protection of interconnect cables, conductors and contacts is a standard requirement especially when frequent mating and unmating is required, or when cables are routed through exposed intercar or undercar locations. To ensure rapid and accurate car linking and cabin reconfigurations, interconnects must be easy to couple and keyed to avoid mis-mating. Vibration, shock and connector decoupling problems are also common in rail applications, and require focused attention when selecting shell materials and mating technologies. As passenger and crew safety is paramount, interconnection systems must not compound flammability, smoke or toxicity risks.

Eye-Beam™ fiber optics in a ruggedized, reverse-bayonet connector package meet the environmental challenges of rail systems

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But make no mistake: the overriding challenge is environmental. Rail and transportation systems represent one of the most challenging environments for the long-term survivability and reliability of interconnect cables and assemblies. From high-speed rail transportation systems to heavy railway freight lines, the standard daily fare of the rail industry is one harsh environmental challenge after another.

Glenair Eye-Beam™ fiber optics in a ruggedized, reverse-bayonet connector package meet the environmental challenges of rail systems, standing up to shock, vibration, moisture, and temperature fluctuation while delivering the reliable high-speed data transmission advantages of fiber optics.

Fiber Optics for High Definition Broadcasting

Fiber optic systems are implemented in remote television broadcast systems for sporting events or on-location news reporting. In the television industry this is known as electronic field production, or EFP. Multi-camera video editing, advanced graphics and sound equipment must be reliable and portable, built into a truck or van—a "control room on wheels"—where space is at a premium.

On board the SIVision High-Definition mobile broadcasting unit—a "control room on wheels" for audio and video electronic field production.

A single fiber optic connection can simultaneously transport bidirectional digital and analog video, as well as two-way camera control, audio, data, sync, tally/call, prompter, and intercom signals between a high-definition camera and the mobile studio truck. A fiber optic system transmits signals digitally and optically, so broadcasters and producers are assured of the highest quality audio and video, free from interference or grounding problems.

Broadcast fiber optic interconnect systems must be quickly deployable for on-location news broadcasting, and able to stand up to the rigorous conditions presented on the sidelines of a football game or a weather report from the site of a tropical storm. Glenair Eye-Beam™ termini provide the space-saving and lightweight, yet rugged and durable connection that this exciting industry demands.

Eye-Beam™ Solutions and Future Applications

At Glenair, we are serious about the business of engineering the right solution for every application. We continue to design and enhance fiber optic solutions for standard military and commercial connectors, and develop new fiber optic technologies for exciting new applications like robotics and future soldier systems.

MIL-DTL-38999 Connectors

The MIL-DTL-38999 connector is currently the most commonly specified multi-pin cylindrical interconnect in fiber optic aerospace applications. When used to connect multiple strands of fiber simultaneously, the D38999 connector functions as a container or shell for the precision termini which perform the actual marriage of the fiber strands.

Glenair's unique alignment techniques maximize optical performance and provide reliable, repeatable interconnection of optical fibers. Ferrule design—critical to performance—has traditionally relied upon a machined stainless steel terminus incorporating a precision micro drilled hole. Glenair's unique precision ceramic ferrules,

with concentricity and diametric tolerances controlled within one micron (.00004 of an inch), meet the needs of high bandwidth and low allowable insertion loss applications. In fact, Glenair's ferrules are approximately 10 times more accurate than alternative designs, and have reduced insertion loss values from 1.5dB to less than .5dB (typical loss for Glenair termini is .3 dB).

Glenair has engineered Eye-Beam™ D38999 connectors for use in applications such as high definition video camera equipment, high speed routers for long haul transmission, and military and commercial avionics applications.

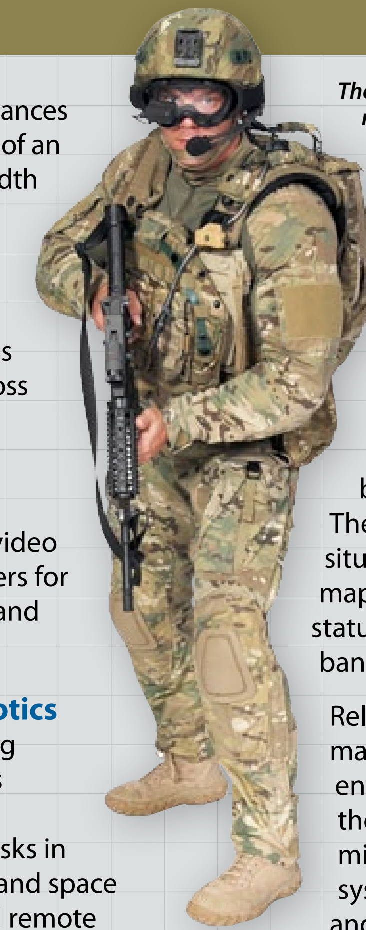
Eye-Beam™ Fiber Optics in Robotics

Robots are relied on in manufacturing and industry to do jobs in dangerous or dirty environments. They are also employed in increasingly complex tasks in bomb detection and disposal, earth and space exploration, laboratory research, and remote surgical systems. Glenair COTS (Commercial Off-The-Shelf) Eye-Beam™ fiber optic termini can provide reliable high-speed data transmission in the challenging environments that these robotic applications present.

GFOCA Hermaphroditic Fiber Optic Connection System

Hermaphroditic coupling eliminates the need for adapters and male and female mating halves. Hermaphroditic housings also allow for rapid deployment without the use of male and female mating halves or other adapters, creating low loss Singlemode, Multimode and Hybrid "daisy- chained" links in a variety of insert arrangements

The rugged and reliable Glenair GFOCA Connection System with Eye-Beam™ termini is used by the Army for long-run battlefield ground system communications, and is also well suited to dockside naval communications, down-hole drilling and other harsh environment applications.



The Future Force Warrior System depends on a highly reliable, low-data loss connection system that is lightweight and able to stand up to rigorous use in challenging environmental conditions.

Eye-Beam™ and the Future Force Warrior

Future Force Warrior is a United States military project developing a lightweight, fully integrated combat system, implementing nanotechnology, powered exoskeletons, and magnetorheological fluid-based body armor for the "Army After Next." The system provides the soldier with enhanced situational awareness, communication data, maps, tactical intelligence and physiological status monitoring through an integrated high-bandwidth wireless communication system

Reliable data transmission and ruggedized mating/de-mating in the most extreme environmental situations are crucial to the Future Force interconnect system. A miniaturized, GFOCA hermaphroditic cable system with Eye-Beam™ termini for lightweight and reliable data connection is the perfect solution to these challenges.

Retrofitting of existing cable assemblies

Glenair can retrofit your existing cable assemblies with Eye-Beam™ fiber optic termini in your connectors. There is no need to undergo expensive and time-consuming replacement of entire cable systems to take advantage of Eye-Beam™ high reliability and performance.

The Eye-Beam™ Revolution

Glenair continues to make substantial investments in equipment, tooling, research and the industry's best engineering talent to develop new fiber optic technologies. Glenair Eye-Beam™ fiber optic termini solve environmental challenges for today's demanding fiber optic systems, and we will continue to develop the right solutions for tomorrow's applications—especially in the area of expanded beam fiber optic technologies.

Glenair Connector Material and Finish Options

Glenair Connector Material and Finish Options

This chart presents a selection of the broad range of base materials and plating options available for Glenair connectors. Innovation and qualification of material and finish types is a major Glenair strength.

Material and finishes and their specifications are provided for reference only. For detailed material and plating information, particularly relating to testing and performance, please consult factory.

Code	Material	Finish	Finish Specification	Hrs. Salt Spray	Electrical Conductivity	Operating Temp. Range	RoHS	Notes
AB	Marine Bronze	Unplated	AMS 4640 alloy, unplated	1000	Conductive	-65 to +200°C	✓	Marine and geo-physical applications
AL	Aluminum	AlumiPlate, Clear Chromate	MIL-DTL-83488, Class 2, Type II over electroless nickel	500	Conductive	-65 to +175°C	✓	Approved for MIL-DTL-38999L and MIL-DTL-83513G.
C	Aluminum	Anodize, Black	AMS-A-8625 Type II Class 2	336	Non-Conductive	-65 to +175°C	✓	Glenair's standard black anodize finish.
E	Aluminum	Chem Film	MIL-DTL-5541 Type 1 Class 3	168	Conductive	-65 to +175°C		Glenair's standard chem film finish.
G	Aluminum	Anodize, Hardcoat	AMS-A-8625, Type III, Class 1, .001" thick	336	Non-Conductive	-65 to +200°C	✓	Glenair's preferred hardcoat finish.
JF	Aluminum	Cadmium, Gold	SAE-AMS-QQ-P-416 Type II, Class 2 over electroless nickel	48	Conductive	-65 to +175°C		Glenair's preferred gold cadmium finish.
LF	Aluminum	Cadmium, Clear	SAE-AMS-QQ-P-416 Type II Class 2 over electroless nickel	48	Conductive	-65 to +175°C		Glenair's preferred clear cadmium finish.
M	Aluminum	Electroless Nickel	AMS-C-26074 Class 4 Grade B; ASTM-B-733, SC 2, Type IV	48	Conductive	-65 to +200°C	✓	Glenair's standard electroless nickel finish.
MA	Aluminum	Electroless Nickel	AMS-C-26074 Class 4 Grade A	96	Conductive	-65 to +200°C	✓	Standard matte electroless nickel for space applications.
ME	Aluminum	Electroless Nickel	AMS-C-26074 Class 4 Grade A	96	Conductive	-65 to +200°C	✓	Electroless nickel with enhanced corrosion resistance.
MT	Aluminum	Nickel-PTFE	AMS2454	500	Conductive	-65 to +175°C	✓	Approved for MIL-DTL-38999L and MIL-DTL-83513G.
NC	Aluminum	Zinc-Cobalt, Olive Drab	ASTM B 840 Grade 6 Type D over electroless nickel	350	Conductive	-65 to +175°C		Glenair's standard olive drab zinc-cobalt finish.
NF	Aluminum	Cadmium, Olive Drab	SAE-AMS-QQ-P-416 Type II Class 2 over electroless nickel	500	Conductive	-65 to +175°C		Glenair's standard olive drab cadmium finish.
TP2	Titanium	Electrodeposited Nickel	SAE-AMS-QQ-N-290 Class 1 Grade F	96	Conductive	-65 to +200°C	✓	Glenair's preferred finish for titanium connectors.
UC	Aluminum	Zinc-Cobalt, Black	ASTM B 840 Grade 6 Type D over electroless nickel	240	Conductive	-65 to +175°C		Glenair's standard black zinc-cobalt finish.
UCR	Aluminum	Zinc-Cobalt, Black	ASTM B 840 Grade 6 Type D over electroless nickel	240	Conductive	-65 to +175°C	✓	RoHS version of UC.
UF	Aluminum	Cadmium, Black	SAE-AMS-QQ-P-416 Type II Class 2 over electroless nickel	500	Conductive	-65 to +175°C		Glenair's preferred black cadmium finish.
XAL	Composite	AlumiPlate	MIL-DTL-86448, Class 2, Type II over electroless nickel	2000	Conductive	-65 to +175°C	✓	Approved for MIL-DTL-38999L.
XB	Composite	Unplated Black		2000	Non-Conductive	-65 to +175°C	✓	Glenair's standard unplated composite.
XO	Composite	Unplated Amber		2000	Non-Conductive	-65 to +175°C	✓	Unplated composite, Amber color
XM	Composite	Electroless Nickel	AMS-C-26074 Class 4, Grade B	2000	Conductive	-65 to +200°C	✓	Glenair's standard electroless nickel finish over composite.
XMT	Composite	Nickel-PTFE	GMF-002 Type II Class 2	2000	Conductive	-65 to +200°C	✓	Approved for MIL-DTL-38999L.
XW	Composite	Cadmium, Olive Drab	SAE-AMS-QQ-P-416 Type II Class 3 over electroless nickel	2000	Conductive	-65 to +175°C		Glenair's standard olive drab cadmium finish over composite.
XZN	Composite	Zinc-Nickel, Black	ASTM B841 Grade 5 over electroless nickel	2000	Conductive	-65 to +175°C		Glenair's standard black zinc-nickel finish over composite.
Z1	Stainless Steel	Passivate	SAE AMS 2700	500	Conductive	-65 to +200°C	✓	Glenair's standard passivated stainless steel.
Z16	Aluminum	Electroless Nickel	AMS-C-26074 Class 4 Grade B	48	Conductive	-65 to +200°C	✓	Standard matte electroless nickel for space applications
Z2	Aluminum	Gold	MIL-DTL-45204 Class 1 over electroless nickel	48	Conductive	-65 to +200°C	✓	Glenair's standard gold plating for space programs.
ZC	Stainless Steel	Zinc-Cobalt, Black	ASTM-B840, Grade 6		Conductive	-65 to +175°C		Glenair's standard zinc-cobalt over stainless steel.
ZCR	Stainless Steel	Zinc-Cobalt, Black	ASTM-B840, Grade 6		Conductive	-65 to +175°C	✓	RoHS version of ZC.
ZL	Stainless Steel	Electrodeposited Nickel	SAE-AMS-QQ-N-290 Class 2 Grade F	500	Conductive	-65 to +200°C	✓	Glenair's preferred nickel-plated stainless steel.
ZM	Stainless Steel	Electroless Nickel	AMS-C-26074 Class 1 Grade A		Conductive	-65 to +200°C	✓	Used on hermetic connectors. Use ZM for other applications.
ZMT	Stainless Steel	Nickel-PTFE	AMS2454	1000	Conductive	-65 to +175°C	✓	Glenair's new 1000 Hour Grey over stainless steel.
ZN	Aluminum	Zinc-Nickel, Olive Drab	ASTM B841 Grade 5 over electroless nickel	500	Conductive	-65 to +175°C		Glenair's standard olive drab zinc-nickel finish.
ZNU	Aluminum	Zinc-Nickel, Black	ASTM B841 Grade 5 over electroless nickel	500	Conductive	-65 to +175°C		Use ZR for new design
ZU	Stainless Steel	Cadmium, Black	SAE-AMS-QQ-P-416 Type II Class 2	500	Conductive	-65 to +175°C		Glenair's standard black cadmium over stainless steel.
ZW	Stainless Steel	Cadmium, Olive Drab	SAE-AMS-QQ-P-416 Type II Class 2 over electroless nickel	500	Conductive	-65 to +175°C		Glenair's standard olive drab cadmium over stainless steel.
ZR	Aluminum	Zinc-Nickel, Black	ASTM B841 Grade 5 over electroless nickel	500	Conductive	-65 to +175°C	✓	Glenair's RoHS compliant black zinc-nickel

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Glenair Connector Plating Code and Mil-Spec Connector Finish Code Cross-Reference

MIL-DTL-38999 Series I and II Finish Code	Material, Finish	Recommended Glenair Material/Finish Code
A	Aluminum, Cadmium Plated, Clear Chromate	LF
B	Aluminum, Cadmium Plated, Olive Drab	NF
C	Aluminum, Anodize, Hardcoat	G
E	Stainless Steel, Passivated	Z1
F	Aluminum, Electroless Nickel Plated	M
N	Stainless Steel, Electrodeposited Nickel (Hermetic)	ZL
P	Aluminum, Pure Dense Aluminum (AlumiPlate℠)	AL
R	Aluminum, Electroless Nickel	ME
T	Aluminum, Nickel-PTFE	MT
U	Aluminum, Cadmium Plated, Clear Chromate	LF
X	Aluminum, Cadmium Plated, Olive Drab	NF
Z	Aluminum, Black Zinc-Nickel	ZR

MIL-DTL-38999 Series III and IV Class Code	Material, Finish	Recommended Glenair Material/Finish Code
C	Aluminum, Anodize, Hardcoat	G
F	Aluminum, Electroless Nickel	M
G	Aluminum, Electroless Nickel (Space Grade)	MA
H	Stainless Steel, Passivated (Space Grade)	Z1
J	Composite, Cadmium Plated, Olive Drab	XW
K	Stainless Steel, Passivated	Z1
L	Stainless Steel, Electrodeposited Nickel	ZL
M	Composite, Electroless Nickel Plated	XM
N	Stainless Steel, Electrodeposited Nickel (Hermetic)	ZL
P	Aluminum, Pure Dense Aluminum (AlumiPlate℠)	AL
R	Aluminum, Electroless Nickel	ME
S	Stainless Steel, Electrodeposited Nickel	ZL
T	Aluminum, Nickel-PTFE	MT
W	Aluminum, Cadmium Plated, Olive Drab	NF
X	Aluminum, Cadmium Plated, Olive Drab	NF
Y	Stainless Steel, Passivated	Z1
Z	Aluminum, Black Zinc-Nickel	ZR

Glenair Connector Plating Code and Mil-Spec Connector Finish Code Cross-Reference

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MIL-DTL-28840 Finish Code	Material, Finish	Recommended Glenair Material/Finish Code
A	Aluminum, Cadmium Olive Drab over Nickel	NF
B	Stainless Steel, Cadmium-Black over Nickel	ZU
L	Aluminum, Nickel PTFE	MT
S	Aluminum, Zinc Nickel, Non-Reflective	ZR

SAE AS5015 Class Code	Material, Finish	Recommended Glenair Material/Finish Code
A, B, C, D, E, DJ, F, P, R, W	Aluminum, Cadmium Plated, Olive Drab	NF
H, K	Stainless Steel, Electroless Nickel	ZM
L,U	Aluminum, Electroless Nickel	M

MIL-DTL-26482	Material, Finish	Recommended Glenair Material/Finish Code
Series I	Aluminum, Cadmium Plated, Olive Drab	NF
Series 2 Class L	Electroless Nickel	M
Series 2 Class W	Aluminum, Cadmium Plated, Olive Drab	NF

AS85049 Finish Code	Material, Finish	Recommended Glenair Material/Finish Code
A	Aluminum, Black Anodize	C
B	Stainless Steel, Cadmium Plated, Black	ZU
G	Aluminum, Electroless Nickel Plated (Space)	M
J	Composite, Cadmium Plated, Olive Drab	XW
L	Composite, Cadmium Plated, Olive Drab(1)	XX
M	Composite, Electroless Nickel Plated	XM
N	Aluminum, Electroless Nickel Plated	M
P	Aluminum, Cadmium Plated, Olive Drab(1)	NFP
W	Aluminum, Cadmium Plated, Olive Drab	NF
T	Composite, Unplated	XO
	(1) Selective plated with polysulfide barrier	

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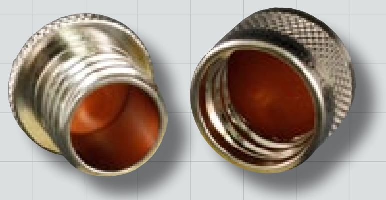
Quick Picks: A Guide to Glenair's Most Popular Materials and Finishes



Electroless Nickel

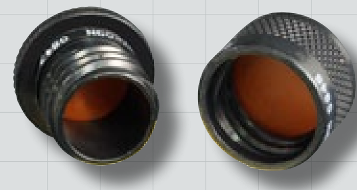
Cost $ $ $ $ $
Conductivity + + + + +
Corrosion Resistance ⧗ ⧗ ⧗ ⧗ ⧗

-65 to +200°C

Glenair Code M

RoHS Compliant

Aluminum plated with electroless nickel offers excellent conductivity, wear resistance, and adequate corrosion resistance. Typically specified on electrical connectors and accessories used in avionics boxes, exoatmospheric equipment, and missiles, electroless nickel is a good choice when exposure to marine or corrosive atmospheres is not a primary concern. The plating process is purely chemical, and once started, is autocatalytic (it runs by itself).



Black Zinc Nickel

Cost $ $ $ $ $
Conductivity + + + + +
Corrosion Resistance ⧗ ⧗ ⧗ ⧗ ⧗

-65 to +175°C

Glenair Code ZR

RoHS Compliant

RoHS-compliant black zinc-nickel is approved for MIL-DTL-38999, AS85049 and other major military specifications as a replacement for cadmium and hexavalent chromium platings. The non-reflective finish and good conductivity make the Glenair ZR finish a leading choice for cadmium-free tactical systems. Corrosion resistance is comparable to cadmium, and the ZR finish is backward-compatible with Cd-plated connectors and accessories.

Zinc-Cobalt

Cost $ $ $ $ $
Conductivity + + + + +
Corrosion Resistance ⧗ ⧗ ⧗ ⧗ ⧗

-65 to +175°C

Glenair Code UC, UCR, ZC, ZCR

RoHS Compliant

Zinc-cobalt with black trivalent chromate topcoat fills the need for a RoHS compliant conductive black finish for soldier systems, unmanned vehicles, robots and other tactical gear. This new addition to the Glenair lineup is likely to replace black zinc-nickel for new Future Combat System applications. Black zinc-cobalt plating is a standard finish on Glenair's ITS 5015 reverse bayonet power connectors.

Zinc-Nickel

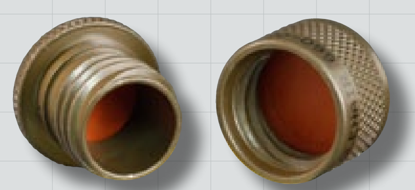
Cost $ $ $ $ $
Conductivity + + + + +
Corrosion Resistance ⧗ ⧗ ⧗ ⧗ ⧗

-65 to +175°C

Glenair Code ZN, ZNU

RoHS Not Compliant

Recently added to MIL-DTL-38999 and MIL-DTL-83513, zinc-nickel plated aluminum has become a cost-effective alternative to cadmium. Available with olive drab or black chromate conversion coatings, zinc-nickel plated aluminum is commonly found on soldier systems and military airframe applications.



Cadmium

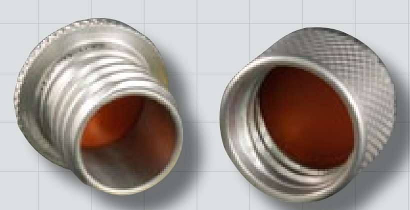
Cost $ $ $ $ $
Conductivity + + + + +
Corrosion Resistance ⧗ ⧗ ⧗ ⧗ ⧗

-65 to +175°C

Glenair Code NF, LF, JF

RoHS Not Compliant

Cadmium plated aluminum has been the unchallenged workhorse of the defense/aerospace industry. Offering up to 1000 hours of salt spray protection when deposited over electroless nickel, cadmium is highly conductive, and provides good lubricity and resistance to galling. As plated, cadmium has a silvery appearance. A subsequent chromic acid passivation bath creates a chromate topcoat over the cadmium, enhancing corrosion protection. Olive drab chromate is widely used, followed by gold chromate and clear chromate.



Stainless Steel

Cost $ $ $ $ $
Conductivity + + + + +
Corrosion Resistance ⧗ ⧗ ⧗ ⧗ ⧗

-65 to +200°C

Glenair Code Z1, ZL, ZW

RoHS Compliant

Stainless steel offers unbeatable strength and protection from environmental stress if durability and corrosion resistance are more important than cost and weight. Typically found on aircraft engines, landing gear, geophysical equipment, armored vehicles and marine applications, passivated stainless steel is widely specified in throughout the interconnect industry. Also offered with nickel and cadmium plating for improved conductivity, stainless steel is an obvious alternative to cadmium if cost and weight are not an issue.

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Quick Picks: A Guide to Glenair's Most Popular Materials and Finishes

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Black Anodize

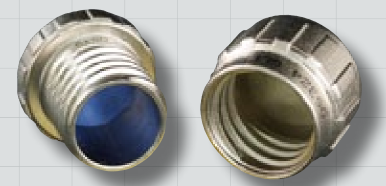
Cost: $ (1 of 5)
Conductivity: + (0 of 5)
Corrosion Resistance: (2 of 5)

-65 to +175°C

Glenair Code C

RoHS Compliant

Black anodized aluminum is a popular finish for electrical connectors and accessories. Typically employed when conductivity is not required, black anodized aluminum offers a modicum of corrosion protection and is relatively inexpensive. Anodizing is an electrolytic process that creates aluminum oxide films by oxidizing the base metal. The resulting coating is much harder and denser than natural oxidation. The parts are immersed in a sulfuric acid solution at room temperature. After anodizing, the parts are dyed black.



Plated Composite

Cost: $ (2 of 5)
Conductivity: + (5 of 5)
Corrosion Resistance: (5 of 5)

-65 to +200°C

Glenair Code XM, XW, XMT

RoHS Compliant

Plated composite connectors and accessories provide unsurpassed corrosion protection and excellent conductivity. Glass-reinforced thermoplastic is metallized and plated with electroless nickel (olive drab cadmium is another popular finish). Plated composite connectors and accessories have become the first choice for aerospace programs seeking to eliminate cadmium and reduce weight.

Unplated Composite

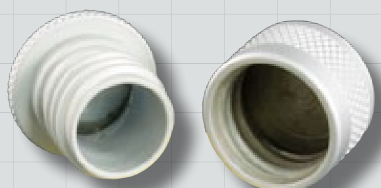
Cost: $ (1 of 5)
Conductivity: + (0 of 5)
Corrosion Resistance: (5 of 5)

-65 to +175°C

Glenair Code XB, XO

RoHS Compliant

If conductivity and EMI shielding are not required, unplated composites provide the best solution to corrosion protection. Glenair's composite connector accessories are ideally suited for use in harsh environments where even stainless steel parts can be attacked by corrosive fluids. Available in black (code XB) and brown (code XO).



AlumiPlate℠

Cost: $ (5 of 5)
Conductivity: + (5 of 5)
Corrosion Resistance: (4 of 5)

-65 to +175°C

Glenair Code AL, XAL

RoHS Compliant

AlumiPlate provides excellent conductivity and corrosion resistance. 99.99% pure aluminum is electrolytically deposited onto aluminum or composite in a specialized water-free process, followed by a trivalent chromate conversion coating. AlumiPlate has been approved by Boeing and Lockheed as a replacement for cadmium. AlumiPlate has been added to MIL-DTL-38999 and MIL-DTL-83513. Threaded parts require dry lube to prevent galling. AlumiPlate is a service mark of AlumiPlate Incorporated, Minneapolis, Minnesota.

Nickel-PTFE

Cost: $ (4 of 5)
Conductivity: + (5 of 5)
Corrosion Resistance: (4 of 5)

-65 to +175°C

Glenair Code MT, XMT, ZMT

RoHS Compliant

Now approved for MIL-DTL-38999 and MIL-DTL-83513, Glenair's 1000 Hour Grey™ meets the need for a cadmium replacement with excellent conductivity, wear resistance and corrosion protection. This extremely durable finish is gun-metal gray. A proprietary preliminary undercoat is followed with a composite coating of electroless nickel phosphorus and polytetra-fluoroethylene (PTFE). An organic topcoat provides sealing and added resistance to SO2 salt fog. Ni-PTFE is approved for the Joint Strike Fighter and offers extremely good lubricity.

Hardcoat Anodize

Cost: $ (3 of 5)
Conductivity: + (0 of 5)
Corrosion Resistance: (3 of 5)

-65 to +200°C

Glenair Code G

RoHS Compliant

Hardcoat anodized aluminum offers greater wear resistance and better corrosion resistance compared to conventional anodizing. Typically employed when conductivity is not required, hardcoat aluminum offers good corrosion protection for marine and tactical applications. The resulting finish is a matte greenish-gray color. Hardcoat anodizing is an electrolytic process that creates aluminum oxide films by oxidizing the base metal in a sulfuric acid solution. The parts are immersed in a sulfuric acid solution at cold temperature. After anodizing, the parts can be dyed black (code GB).

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