QwikConnect

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Drawing a Bead on Wire Protection Products

"Wheels Up"

Wheels up is such simple phrase. It belies the complexity of what it describes—the myriad actions required of landing gear to get a plane airborne.

Landing gear systems are chock full of electronic controls, sensors, and interconnect wiring. From retractor activators to tire air pressure monitors, every aspect of system action must be effectively controlled and monitored from the cockpit. It goes without saying that the wire circuits that transmit this critical data must be extremely reliable.

Landing gear systems are subject to extreme environmental and physical conditions. Imagine how many times landing gear wiring must flex and bend under severe vibration. Repeated hard landings and impact from debris in flight and on runways also take their toll on the gear. Temperatures during braking can exceed 200°C, while at cruising altitude sink to -54°C. Routine chemical exposures include ozone, jet fuel, hydraulic fluid and de-icing solutions.

There are numerous examples in the annals of flight history in which landing gear malfunctions have led to serious flight safety conditions. In some instances, malfunctions have resulted from mechanical problems, such as might occur as the result of foreign object damage. But other examples, such as a recent commercial jet incident in Boston, have been directly linked to environmental damage in critical sensors (in this case a circuit short caused by corrosion). But whatever the source, it is paramount that interconnect cabling servicing electronic devices in landing gear provide robust physical, environmental and EMI protection of individual wires and connectors. And it is absolutely the case that for many applications the best available solution is not a standard shielded and jacketed cable.

Stranded wire bundles, woven together and covered in a protective jacket or sheath, are certainly well suited for many applications, even within landing gear systems. But alternative solutions for wire and circuit protection—such as metal-core conduit—can deliver significant advantages over standard cable including better resistance to impact damage from foreign objects. And recent advances in polymer plastic technology now enable designers to realize the benefits of flexible tubing while reducing the overall weight of the interconnect system.

Aircraft landing gear is not the only application where alternatives to standard jacketed cable are commonly preferred. In fact, there are many other industries and examples in which conduit systems are considered an ideal wire protection solution due to a wide range of performance attributes including better electromagnetic compatibility, advanced mechanical strength, flexibility and more.

The “pilot” on a regional train is a perfect additional example. The “pilot” or “cow-catcher” protects the locomotive and its engineers by deflecting railway obstacles up and away from the nose of the train. Bundles of critical wires are routed directly behind the pilot, and pass beneath the locomotive en route to the train’s many sensors and controls. These wires must be protected from snow, rain, mud, heat, cold, diesel, oil, vibration, and pelting from small objects that evade the pilot’s armor.

...it is absolutely the case that for many applications the best available solution is not a standard jacketed cable.

As with the landing gear application above, high-performance convoluted tubing systems, made from high-temperature polymer plastics and reinforced with metal braiding or stainless steel wire, are perfectly suited for the difficult environmental challenges that lurk behind a train pilot. Such systems can be augmented with special environmental and/or EMI fittings, shrink boots, and metal and fabric braiding for additional protection.

Glenair has worked with customers worldwide to design literally thousands of wire and circuit protection systems that leverage our unique array

The “pilot” protects the locomotive and its engineers by deflecting obstacles away from the train. Interconnect wiring behind the pilot sees some mighty rough duty.

of high-performance wire protection materials. Depending on the requirements of the application, we often recommend PEEK tubing, helically wound with stainless steel wire for outstanding crush and pull resistance, and terminated with aluminum or composite fittings, hardened against all classes of environmental, mechanical or EMI damage. In other applications we might propose our special injection overmold technology to reliably seal circuits from jet fuel or other chemicals. Whatever the protection requirement, from extreme temperatures to reliable resistance to crush damage, Glenair offers wire and circuit protection solutions that can outlast and outperform even the most aggressively armored cable. And we can do it with materials that promote weight reduction and facilitate ongoing maintenance and repair.

In the article that follows we’ll discuss the details of Glenair’s wire protection solutions, including our unique polymer tubing options, metal-core conduit systems, connector overmolds, metal and fabric overbraiding, heat shrinkable boots and more. When were done, we think you’ll agree that when it comes to protecting critical wires and circuits from damage in rough application environments, Glenair is “wheels up” and ready to roll.

Glenair Wire and Circuit Protection Solutions

Glenair is in the business of providing design, engineering, fabrication and termination of high reliability interconnect systems. In addition to the military standard and commercial connectors and backshells that make up our core business, we also produce a specialized range of wire and circuit protection products such as convoluted tubing, fittings and boots. Many of these products are produced to comply with various military standards such as the MIL-PRF-24758 standard that regulates the routing of wires in topside shipboard applications. Others are intended for use in airframe applications, military vehicles, rail and transportation systems and so on.

But regardless of their application, the purpose of these products is to protect wiring (both electrical and optical) from mechanical damage and to seal the system at termination junctures, such as at a connector or a feed-thru device. Interconnect reliability in mission-critical applications is also heavily reliant on the provision of EMI shielding along the full length of the conductor and at connector mating and contact termination points.

While these functions can be fulfilled by shielded and jacketed cables and accessories, many applications require alternative approaches. The wire harnesses under the hood of your automobile, for example, are rarely enclosed in cable jacketing as the complexity of the routing and the shear number of interconnected devices makes this an impractical choice. Car manufactures typically use convoluted tubing made from high-temperature polymer plastic to protect these wire bundles as it provides the right amount of protection from engine heat and abrasion damage while allowing for easy routing of the wires.

Hazards to wiring and circuits include water and other liquid ingress; nuclear, biological and chemical (NBC) contamination; over-stressing from bending; friction, shock and vibration during system operation; breakage at transitions and terminations; combustion; temperature and pressure extremes; pull forces; aging; and, of course, wiring can be

Under-the-hood wiring is frequently a combination of insulated wire bundles, jacketed cables and polymer plastic convoluted tubing used to protect circuits subject to heat or abrasion damage. In late model engine applications, under-the-hood temperatures are considerably higher and often require the use of special high-temperature conduit materials to effectively protect wire circuits.

a victim or source of EMI. There are many ways to protect wiring, and the choice of which product to use depends on the nature of the potential electromagnetic interference, environmental damage and physical abuse experienced by the assembly. Other factors, such as the ability to readily open the system for repair, add or subtract individual wires from the assembly, or reduce weight also come into play.

Here is a list of the wire protection capabilities currently offered by Glenair:

- Various configurations of high-temperature polymer plastic tubing systems, together with a host of fittings, transitions, adapters and other accessories used in routing and termination.
- Flexible metal-core conduit systems in brass, nickel-iron, and stainless steel; again with a whole host of appropriate shielding materials, fittings and accessories used to incorporate connectors, feed-thrus and other devices into the system.
- Heat shrink boots and other molded shapes used to provide strain-relief and environmental sealing, typically on the back end of a connector/backshell assembly.

- Braided tubular fabric products used to provide mechanical protection, such as abrasion resistance on wire, cable and conduit assemblies.
- Metal and metal-clad composite braided shielding used to add strength to wire harnesses and conduit assemblies and also to provide a ground path for EMI in shielded applications.
- High-performance jacketing for conduit and cables: Glenair produces a number of specialized jacketing materials used in our wire protection conduit assemblies as well as in customer bespoke cable harnesses
- Connector overmolding capability: Glenair has a unique strength in the industry, with an overmolding solution tooled for virtually every connector and backshell assembly currently in use in our industry. This capability allows us to provide advanced levels of environmental and mechanical protection for cable and conduit assemblies that are deployed in applications such as fuel cells, oil fields and other caustic chemical environments.

Metal-Core Conduit and Convoluted Tubing Wiring Systems

Conduit systems, whether made from advanced polymer plastic tubing or flexible metal-core materials, offer significant advantages over standard jacketed cable. For instance, conduit systems are easier to install and repair, whether with factory- or field-installable fittings. Conduit is also ideal for prototyping and mock-ups, as well as for systems that may require periodic expansion of available circuits.

Glenair's plastic tubing provides a lightweight, durable, highly flexible enclosure for wiring systems, with end and transition fittings available to meet almost any installation configuration. A range of standard diameters and wall thicknesses are available to accommodate any application using circular or rectangular connectors. Series 72 annular convoluted tubing is constructed from thermally stable Kynar, making it radiation and chemical resistant. Series 74 helical tubing is available in the industry's broadest range of materials including Ultem, PTFE, Tefzel, PFA, FEP, Kynar, and halogen-free, lightweight PEEK.

Convoluted Tubing Materials Available From Glenair

MATERIAL PROPERTY	PERFLUORO-ALKOXY (PFA)	FLUORINATED ETH-YLENE PROPYLENE (FEP)	ETHYLENE TETRA-FLUOROETHYLENE (ETFE)	POLYTETRAFLU-OROETHYLENE (PTFE)	POLYVINYLIDENE FLUORIDE (PVDF)	POLYETHER KETONE (PEEK)
Service Temperature	-95°F/500°F (-71°C/260°C)	-95°F/400°F (-71°C/204°C)	-65°F/310°F (-54°C/154°C)	-95°/500°F (-71°C/260°C)	-65°F/330°F (-54°C/166°C)	-76°F/392°F (-60°C/200°C)
Tensile Strength	3,000 PSI (20,684 KP)	2,500 PSI (17,237 KP)	5,000 PSI (34,474 KP)	2,500 PSI (17,237 KP)	5,000 PSI (34,474 KP)	7,000 PSI (48,300 KP)
Elongation	250%	200%	100%	175%	250%	100%
Specific Gravity	2.15	2.15	1.70	2.15	1.8 Max	1.26
Heat Aging	2000 Hrs.@ 525°F (274°C)	2000 Hrs.@ 430°F (221°C)	2000 Hrs.@ 350°F (177°C)	2000 Hrs. @ 525°F (274°C)	168 Hrs. @ 347°F (175°C)	2,000 Hrs. @ 464°F (240°C)
Dielectric Strength	12,000V	12,000V	12,000V	12,000V	10,000V	12,000V
Volume Resistivity	1018	1018	1016	1018	1016	1016
Water Absorption	0.03%	0.01%	0.02%	0.01%	0.02%	0.03%
Solvent Resistance	No swelling, stickiness or weight change					
Flammability	Non-burning					
Fungus Resistance	Does not support fungus growth					

High Voltage Electrical Power Distribution

From 0 to 60 in 3.9 Seconds

High voltage electrical power distribution is a critical component of the 100% electric Tesla Roadster.

The reliable distribution of electrical energy from the car's lithium-ion energy storage system to the vehicle's motor, electronic control module, HVAC system, transmission and regenerative braking unit depends on a high-performance wiring system made up of high-temperature shielded conduit and ruggedized reverse-bayonet power connectors—all made by Glenair.

Glenair is on the forefront of innovative efforts to advance the reliability and performance of electric vehicles. Glenair power connectors, cables and conduit are deployed in high-voltage power management and distribution applications for systems as demanding as military vehicles —and as fast as the Tesla Roadster.

Glenair®

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When combined with braided shielding and jacketing, these conduit systems offer outstanding electromagnetic interference (EMI), electromagnetic pulse (EMP), mechanical and environmental protection. Braided shielding, addressed in more detail below, is available in a variety of metal, metallized thermoplastic and expandable fabric. Jacketing material options include EPDM, Hypalon, Neoprene, Viton and our new high performance "BlueJacket" covering.

Accessory bulkhead fittings, adapters and feed-thrus provide cable routing flexibility on electrical or optical systems, and Glenair offers a wide selection of user-installable hardware for annular and convoluted tubing. Or, let Glenair's factory experts terminate interconnect tubing systems in standard configurations, customized designs and wired conduit assemblies. Choose fittings in standard aluminum, brass, stainless steel or composite thermoplastic with a full range of plating options.

Series 75 Flexible Metal-Core

Glenair's Flexible Metal Core Conduit systems offer state of the art EMI protection, from simple electrical grounding to TEMPEST secure communications, and provide complete compatibility with virtually every type of electrical connector. Series 75 Metal Core Conduit enclosures facilitate interconnection with outstanding wiring protection in harsh environments such as above-deck shipboard use, vehicular and heavy machinery as well as airborne and submarine applications.

Available materials include helically wound brass, nickel iron, and stainless steel, with welds at each joint to ensure a continuous airtight seal. Series 75 Metal Core Conduit offers superior crush resistance, environmental/NBC protection, abrasion resistance and flexibility, along with optimum EMI shielding. Depending on your EMI, mechanical or environmental requirements, a broad selection of overbraiding, shielding and jacketing is available in such materials as tinned copper, nickel copper, phosphorous bronze, stainless steel, Nomex, Halar, PEEK, Dacron, Kevlar and Aramid.

Choose from factory- or user-installable hardware to allow for maximum versatility. Glenair offers the industry's widest range of conduit termination fittings, from circular and rectangular connector fittings to transitions, bulkhead feed-thru adapters and more. Series 75 flexible metal-core conduit factory terminated assemblies are ideal for connector-to-connector and connector-to adapter or transition

Conduit Jacketing Materials Available From Glenair

MATERIAL PROPERTY	EPDM (Ethylene Propylene Diene Monomer)	HYPALON (Chlorosulfonated Polyethylene)	NEOPRENE (Polychloroprene)	VITON (Fluoroelastomer)
Temperature Range	-60°F to +300°F (-51°C to +149°C)	-60°F to +300°F (-51°C to +149°C)	-60°F to +250°F (-51°C to +121°C)	-40°F to +392°F (-40°C to +200°C)
Specific Gravity	1.26	1.18	1.25	1.80
Weight: Lbs./Cubic Inch	.045	.043	.045	.055
Abrasion Resistance	Excellent	Excellent	Excellent	Excellent
Wear Resistance	Good	Good	Good	Good
Flame Resistance	Good	Good	Good	Good
Sunlight Resistance	Good	Excellent	Excellent	Excellent
Chemical Resistance:				
Aliphatic Hydrocarbons	Good	Good	Good	Excellent
Aromatic Hydrocarbons	Good	Fair	Fair	Excellent
Ketones, Etc.	Good	Poor	Poor	Poor
Oil & Gasoline	Good	Good	Good	Excellent

applications. All braided shields along with the conduit are securely and permanently attached to the fittings with less than one milliohm DC resistance across the termination. Our huge range of user-installable fittings provides complete assembly convenience, maintenance and repair of wiring systems. In addition, we offer Same Day availability of bulk conduit and common hardware sizes and configurations. Consult the factory for industry-best design engineering on custom breakouts, end fittings, adapters or pre-wired conduit assemblies.

Topside Navy Conduit Systems

Glenair's MIL-PRF-24758A EMI/EMP Conduit System has been approved by the U.S. Navy for use on topside installations. The system is made up of three key elements: brass metal-core conduit, rugged stainless steel end-fittings, and our innovative BlueJacket covering. Bluejacket is available for specification on other Glenair wire protection systems.

Most topside shipboard conduit users have simple expectations—supply conduit fittings that don't leak or corrode yet will last a ship's lifetime. They also want jacketing materials that can withstand high heat, extreme UV radiation, demanding weather conditions and caustic chemicals and fluids. Glenair's U.S. Navy qualified MIL-PRF-24758A conduit system delivers on all of these expectations–and a whole lot more.

Our shielded brass conduit meets all EMI shielding and surface transfer impedance requirements. Our jacket material, which we've named "BlueJacket" in honor of the dedicated Navy personnel who work with these products in arduous conditions, is a special formula that exceeds MIL-PRF-24758A specifications. These demanding requirements include UV weathering, temperature tolerance, low smoke and toxicity index, flame resistance, and halogen free (IEC754-1) ratings.

Our unique fitting design provides the easiest assembly and the most reliable performance ever in topside conduit systems—no more loosening, leaks, corrosion, or costly replacement of barely used components that failed to withstand harsh environmental shipboard challenges. Whether your requirements call for factory terminated M24758A assemblies with lightweight soldered fittings, or field terminated bulk conduit, adapters and fittings, Glenair BlueJacket is "Haze Gray and Underway" and more than ready to exceed your expectations.

Glenair "BlueJacket" fittings are nickel plated 316 stainless steel with improved environmental sealing features. We offer a versatile range of adapters and standardized conduit end fittings. Using a new, proprietary formula, "BlueJacket" weatherproof jacketing achieves:

- Temperature rating: -70°C to +200°C (with excursions to 260°C))
- Halogen free per IEC 60614-1. Less than 5mg of HCl per 1 gm of product tested.
- Accelerated Weathering (Solar) per IEC 60068-2-5; 56 days exposure
- Flame Resistant per IEC 60614-1
- Low Smoke Index per NES 711 (11.75)
- Smoke Density Class F1 Per NF F 16-101 IAW DIN EN 60695-2-11:2001
- Toxicity Index per NES 713 (1.9)
- Colorable to Fed Std 595B
- Markable IAW MIL-PRF-24758A
- Oxygen Limiting Index = 45.1 Per EN ISO 4589-2:1999; Minimum is 28.
- Fluids Per MIL STD 810F, Method 504
- Fuel (MIL-T-83133): JP-8
- Hydraulic Fluid (MIL-H-5606): ROYCO 756
- Lube Oil (MIL-L-23699): ROYCO-500
- Cleaner (MIL-C-85570): CALLA-855
- Solvent (Isopropyl Alcohol): TT-I-735
- De Icer (AMS-1432): E36 Runway Deicer
- Coolant (MIL-C-87252): Coolanol 25R
- Fire Extinguishant Foam: AMEREX AFFF

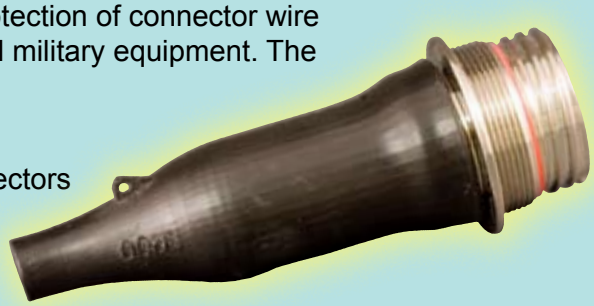
Heat-Shrinkable Molded Shapes

Easy-to-use, semi-rigid heat-shrinkable boots offer excellent electrical, mechanical and environmental protection. Made from flame-retardant elastomeric material, these adhesive-lined boots are resistant to high temperature and chemicals. Shrink boot material is flame retardant, and the “2” option can be specified for compliance to NES smoke and toxicity requirements.

Heating the boot causes the boot to shrink while an adhesive lining bonds the boot to the connector and cable and fills small gaps for a complete seal. Choose straight cable exit or right angle exit.

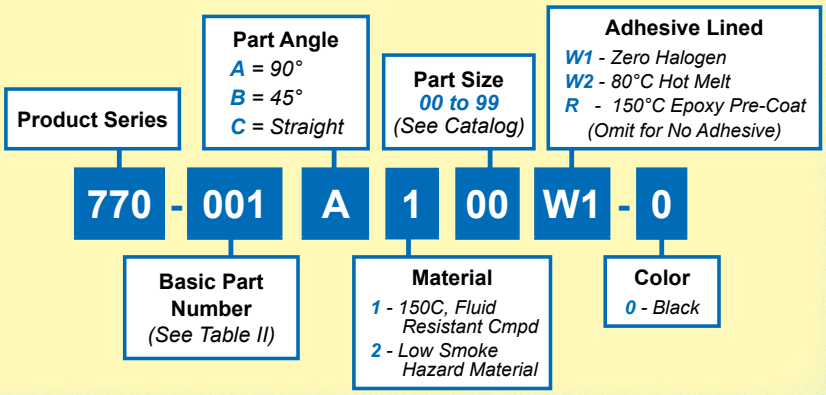
Heat-shrinkable boots are ideal for environmental protection of connector wire terminations in most harsh environments including tactical military equipment. The products also supply a modicum of strain-relief.

Glenair offers a full range of sizes and shapes to accommodate mil-standard circular and rectangular connectors and backshells. Boots are also available for Series 80 Mighty Mouse connectors and accessories.



Shrink Boot Ordering Information

BASIC PART NUMBER	
Basic No.	**Description of part**
001	Lipped Boot with Eyelet
002	Short, Lipped Boot with Eyelet
003	Lipped Boot
004	Short, Lipped Boot
005	Non-Lipped Boot



- Standard Material Fluid Resistant Cross-Linked Elastomer per VG95343 Part 6
- Low Toxicity Material Fluid Resistant Cross-Linked Elastomer per NAVSEA 5617649
- Adhesive Polyamide Hot Melt Minimum Shrink Temperature +135°C
- Recommended Installation Temperature +175°C.
- Fluid/Solvent Resistance
  - Saline – Excellent
  - Hydraulic Fluid – Very Good
  - Lubricating Oil – Very Good
  - Aviation Fuel – Very Good
  - Gasoline – Very Good
  - De-Icing Fluid – Excellent
- Flammability Self-Extinguishing
- Dielectric Strength 480 V/mil

Convoluted Tubing System Designer's Guide

This designers guide is designed to assist you with the selection of components and planning for installation of Glenair polymer plastic and composite convoluted tubing and fittings. Convoluted tubing wire protection assemblies are made up of lengths of bulk convoluted tubing, and various combinations of conduit fittings and adapters that allow the user to efficiently terminated the tubing and attach the assembly to connectors and other interconnect interfaces. There are three basic tasks in the selection process:

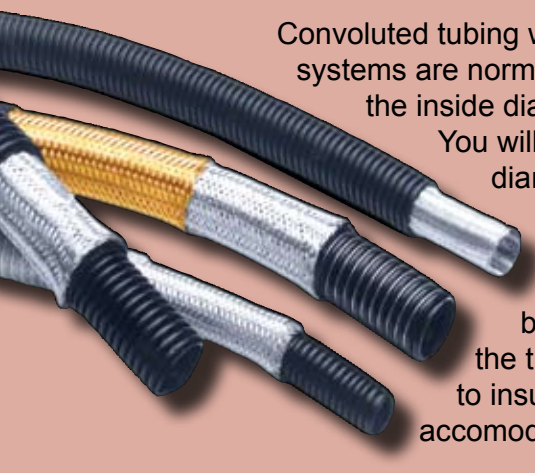
(1) Specify the size of bulk tubing that fits the volume requirements of the application.

(2) Specify the style of bulk tubing which meets the environmental, electrical and mechanical requirements of the application.

(3) Select the transition fittings and connector adapters that satisfy the routing and interconnect requirements of the application.

Step 1: Select Tubing Size

Conduit size is identified by its inside diameter (ID) expressed in inches and fractions. Most of our tubing products range from 3/16 of an inch to 2 inches. The ID is referenced with a numerical size code which is used in the part number.



Convoluted tubing wire protection systems are normally filled to 90% of the inside diameter of the tube. You will need to verify the diameter of the cable or wire bundle to be housed in the tubing before selecting the tubing size in order to insure it adequately accomodates your wiring.

In several product applications, such as when the tubing will ultimately be attached to a bulkhead feed-thru or a stuffing tube, the diameter of the feed-thru fitting needs to be taken into account when selecting the tubing size. Obviously, if the tubing needs to terminate to a one inch feed-thru fitting, you should select one inch tubing. In fact, in a well-designed system, the diameter of the conduit, any necessary transition fittings, connector adapters, feed-throughs etc. should all be the same size.

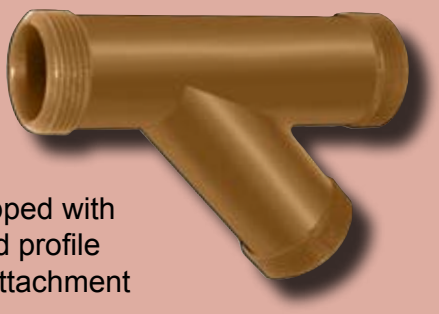
Step 2: Select Tubing Style

Glenair manufactures a wide range of high-temperature tolerant polymer plastic convoluted tubing products, such as PFA, FEP, PTFE, ETFE and PEEK. Each material has specific performance attributes that are summarized in the table on page 7. Selection is most often based on one or more attributes such as crush resistance, strength or cost.

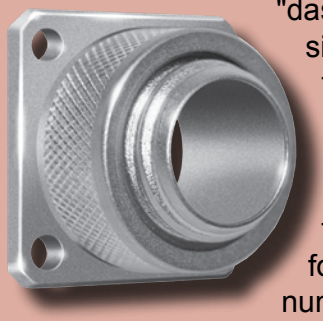
The other decision point in tubing style selection has to do with the addition of outer layers of EMI shielding and/or environmental jacketing to the core material. Braided shielding provides a conductive path for EMI and also adds pull strength to the final assembly. Various formulas of environmental jacketing protect the assembly from moisture and caustic chemicals and provide additional physical protection of the assembly from abrasion and other potential sources of damage.

Step 3: Select Transition Fittings and Connector Adapters

Multi-branch convoluted tubing wire protection assemblies utilize various metal or composite plastic transition fittings, in straight, "T," "Y," and "+" configurations, to facilitate routing. The tubing is terminated into the back end of the fitting while the front end is equipped with an appropriate thread profile and coupler for the attachment



of the necessary transition. The assemblies also utilize connector adapters, in straight 45° and 90° configurations, for the incorporation of circular and rectangular connectors.



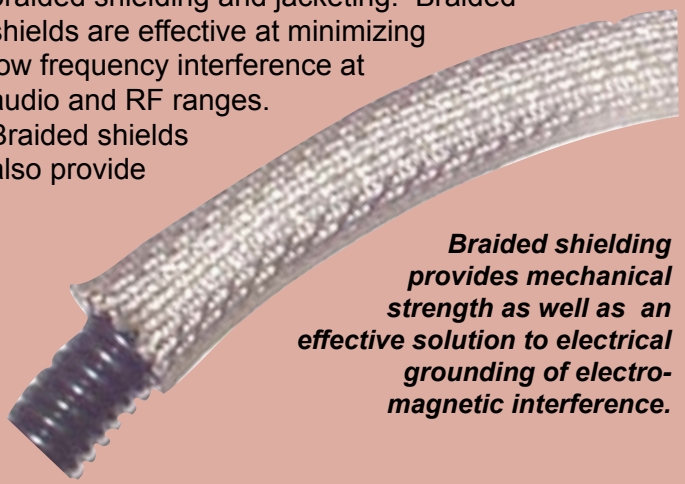
Selection is easy. The size of the fitting or adapter is indicated with a "dash number" or numeric size code that, just like the tubing, corresponds to the shell size of the part in inches and fractions. The appropriate sized fitting for a one inch tube, for example, would be a number "32." Conveniently, this is the same number used for one inch bulk tubing. So selection is a simple matter of matching the size code in the fitting part number with the size code of the selected conduit. Your selection of a straight, 45°, 90°, "T," "Y," or "+" configuartion part will depend on the routing requirements of your system.

NOTE 1: Glenair recommends the use of our TG70 strap wrench, or appropriately sized 600-157 series holding tools for use in fitting-to-fitting, or connector-to-adapter assembly.

NOTE 2: Glenair also recommends the use of torque wrenches to ensure adapters and connectors are mated with the optimal amount of torque.

A Note On Braided Shielding

Glenair is able to provide turnkey convoluted tubing wire protection systems—complete with braided shielding and jacketing. Braided shields are effective at minimizing low frequency interference at audio and RF ranges. Braided shields also provide additional structural integrity while maintaining good flexibility and flex life. In use, the reduction of EMI is dependent upon the signal amplitude and frequency in relation to the many combinations of mesh count, wire diameter and the braid material. Generally, the higher the percentage of braid coverage, the more effective the shield against high-frequency emissions. Available materials include tin-plated copper, nickel-plated copper and tin-plated iron/copper as well as metal-clad composite materials such as AmberStrand®. Depending on the ratio of metal braid to composite plastic, Glenair's composite shielding product can reduce the weight of EMI shielding up to 75%.



Braided shielding provides mechanical strength as well as an effective solution to electrical grounding of electro-magnetic interference.

Glenair takes a systems approach to the design and manufacture of our wire circuit protection systems. This aircraft brake assembly is a perfect example of our complete capability in the manufacturer of both discrete interconnect components as well as the turnkey assembly of wired, terminated and tested systems. Note that this aircraft brake assembly wiring is protected by high-temperature polymer plastic tubing covered with both an EMI/RFI braided shield as well as a fabric overbraid for additional physical protection.

For the Protection You Need, Choose the Name You Trust!

Glenair®

- **Ribbed or Helical Convolutions**
- **Thousands of Flex Cycles**
- **Leak Proof**
- **Full Range of Popular Colors**
- **Now with Advanced Lubricity!**

Custom Jacketed Cables

Glenair offers complete custom design, engineering, assembly and braiding services for molded and repairable cable and conduit assemblies. Our custom assembly expertise extends from one of a kind to mass-produced; from simple, point-to-point, to complex multiple-branch and fiber optic assemblies. Our cable divisions comply with the AS9100 and ISO 9001 international standard as well as with MIL-I-45208A and many of the special requirements of MIL-Q-9858A, while providing wired, terminated and tested cable harnesses to military, industrial and commercial markets worldwide. From molded, fiber optic and electrical fuel-cell cables for the F-18 fighter to Micro-D subminiature harnesses for the telecommunications industry, Glenair's complete capability assembly facilities have the engineering expertise and manufacturing know-how to address any cable assembly challenge.

Glenair's complete capability in interconnect cable assemblies extends to the design and manufacture of custom electrical and fiber optic cable, as well as hybrid electrical/optical configurations. Our custom multi-conductor cable is available with or without extruded or "blown" jacketing, shielding and protective coverings to meet virtually any mechanical, environmental or EMI requirement.

The versatility and size of our cable production facility, which includes planetary winders, cable braiding machines, and thermoplastic extruders, allows for both short, one-time runs, as well as unlimited quantities and lengths. Braided shielding can be applied directly to the cable and is available in tin-plated copper, nickel-plated copper and tin-plated iron/copper and lightweight, high-strength, AmberStrand® thermoplastic material. Protective coverings, such as black Dacron and jacketing made from Neoprene (Polychloroprene) and Hypalon (Chlorosulfonated polyethylene) provide additional mechanical, EMI/EMP and environmental protection. Viton, EPDM, Butyl and Glenair proprietary materials such as the new “BlueJacket” material provide robust protection for cable conductors, connectors, backshells and transitions while enhancing mechanical performance.

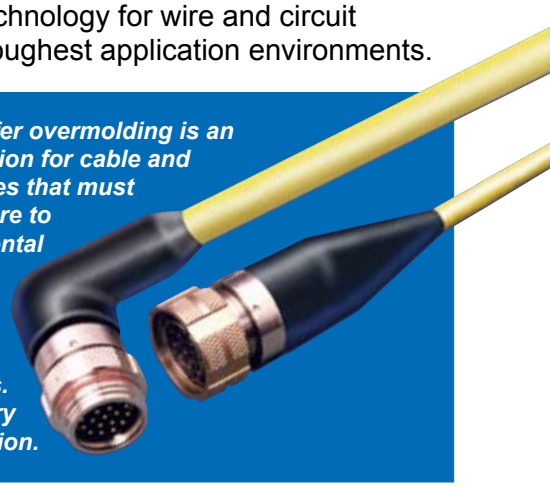
Overmolded Interconnect Cable Assemblies

Environmental and mechanical stress factors require that high performance cable assemblies withstand damage from shock, fluid immersion, abrasion, corrosion, altitude, pull forces and a host of other conditions.

Injection or transfer overmolding is a simple, reasonably priced solution that allows optimal design flexibility and satisfies all of the above mechanical and environmental stress factors. Overmolding, which effectively encapsulates the entire contact termination juncture of the connector and backshell with a high-performance thermoset material, is ideally suited for cable harness assemblies that must withstand extreme levels of abuse, such as are found in aircraft fuel cells or in geophysical applications.

Effectively designed overmolded harnesses can resolve difficult cable routing problems while reducing overall weight and package space when compared to conduit systems. With Glenair’s huge range of standard tooling for all angles and junctions, an almost unlimited range of breakouts and layouts is possible. Straight, 90° and 45° degree angular specifications allow breakouts, bulkhead feed-thrus and transitions tooling for any configuration. Additionally, Glenair offers the industry’s broadest selection of overmolding materials, including Viton and other NBC materials.

Consult Glenair’s ABC cable shop for more information on connector and cable overmolding; a tried and true technology for wire and circuit protection in the toughest application environments.



Injection or transfer overmolding is an outstanding solution for cable and conduit assemblies that must withstand exposure to severe environmental stress factors such as daily exposure to jet fuels or other caustic chemicals. Consult the factory for more information.

EMI/RFI Braided Shielding

Braided shields are effective against low frequency interference at audio and RF ranges. Braided shields also provide additional structural integrity while maintaining good flexibility and flex life. EMI reduction depends on signal amplitude and frequency in relation to mesh count, wire diameter and the braid material. Generally, the higher the percentage of braid shield coverage, the more effective against high-frequency emissions.

Glenair offers complete in-house design and production capability on a huge variety of braiding, expandable sleeving and tubular shielding materials. Boasting more than 50 braiders, ranging from 16 to 96 carriers, Glenair's in-house capacity is truly impressive—whether you need bulk quantities or custom short-runs of precision metal or non-metallic braid, expandable sleeving in tubular, tapered, and flat configurations in virtually any material. EMI/EMP braided may be applied to virtually any wire protection media.

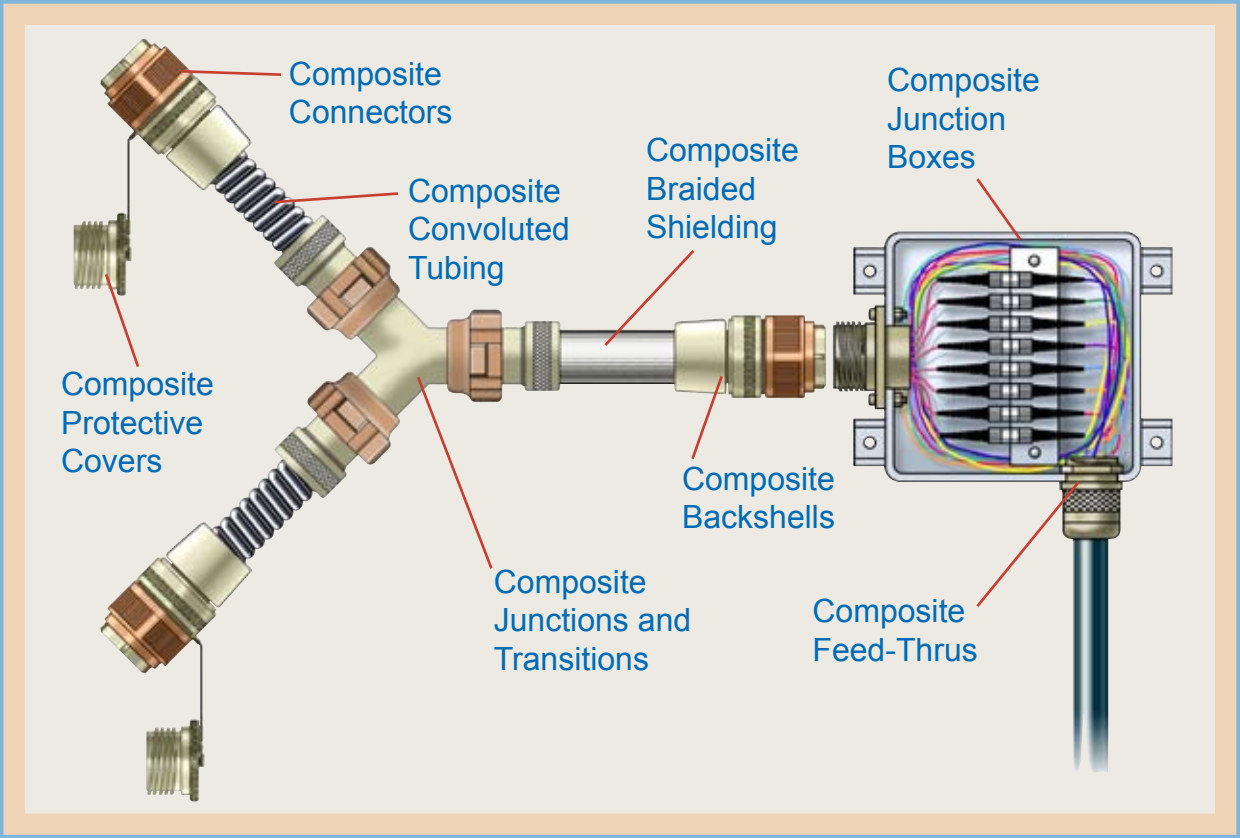
Metal braid is offered in tubular or flat configurations in a variety of sizes from 1/32 inch (0.8 mm) to 2-1/2 inches (63.5 mm), and can easily be slipped over plastic tubing or metal core conduit, wire bundles, cables or similar constructions. Expandable sleeving provides a durable lightweight, economical protective enclosure for all forms of media—including fiber optics. The product is ideally suited for EMI protection of conduit assemblies. Sleeving elasticity accommodates the irregular shapes and sizes of convoluted tubing and conduit to create a smooth profile.

Available braiding materials include bare copper; tin-plated copper-covered steel; copper-plated with tin, nickel or silver; bronze; stainless steel; copper-covered steel; aluminum; Nylon; Dacron®; Nomex®; Kevlar®; PEEK; Teflon®; Ryton®; Halar®; and Polyester. Glenair's unique AmberStrand® braided shielding is ideally suited for reduced weight applications, combining composite technology and metal plating for the lightest EMI shielding in the industry.

AmberStrand® Composite Braid

This nickel plated composite thermoplastic shielding offers excellent electromagnetic compatibility at a fraction of the weight of metal solutions. Metal EMI shielding—especially when applied in multiple layers—can be extremely heavy. Composite thermoplastic AmberStrand® Braid provides excellent EMI protection at about half the weight with no sacrifice in performance over metal braids. Transfer impedance test reports demonstrate AmberStrand's effectiveness. AmberStrand® mechanical properties are comparable to other non-metallic materials.

Composite Thermoplastic Wire Protection



Soup to Nuts

Composite thermoplastic interconnect components are nothing new. Plenty of manufacturers can offer you a selection of these weight-saving, corrosion-free products. But only Glenair has made an across-the-board committment to integrate composite solutions into every facet of the interconnect system.

Glenair can offer today's interconnect engineer the ability to design and build next-generation interconnect cable, box and conduit systems exclusively from composites. From the connector to the backshell, from the dust-cap to the junction box, from the feed-thru to the shielding, from the conduit to the transition—Glenair offers you the freedom to build interconnect systems which are not only light weight and corrosion-free, but just as tough on EMI as traditional metal components. Soup to nuts.

Glenair®

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Inadmissible Evidence

I was watching a re-run of an old Perry Mason murder mystery the other evening and noted something interesting that relates to one of our guiding principles:

> ***Be reality oriented and intellectually honest: Base decisions on an objective view of the facts obtained through your own research and "homework", rather than on optimistic opinions, guesses, assumptions, wishful thinking or outright lies.***

In the TV show, Mason's defense of his client hinges on some controversial evidence being ruled "inadmissible" by the judge. We've all heard the expression "inadmissible evidence." It has to do with the statue of limitations, rules on hearsay, or other protections that prevent the accused from being unfairly confronted with evidence that is considered, for example, so controversial or inflammatory that it should not play a part in the jury's consideration of the case.

This of course is all fine and good in a court of law. But can you imagine the trouble a business would be in if it followed this courtroom model and defined unwelcome business developments as off-limits or inadmissible? What would be the result if a company's leaders consistently turned a blind eye to information that might, for example, reveal a strategic failing, undermine an ill-advised project, or challenge someone's erroneous sense of infallibility? Some companies practice this crazy form of denial right up until the day their enterprise goes belly up.

I sincerely believe that, to the greatest extent possible, we have successfully avoided the trap of putting on blinders when it comes to facing up to the day-to-day challenges of our business. We *are* in fact "reality oriented" when it comes to gathering all the data we need to help us make informed business decisions. In our courtroom, all the evidence is admissible. Keep it up everyone. Raymond Burr would be proud!

On a sad note, the Glenair family recently lost two of its best with the passing of Ralph Smith and James Novacoski. For thirty years Ralph was Glenair's cable and harness product manager and engineer. Along with his many siblings, children and grandchildren, we will miss Ralph's humor and wit, and stories about golf and pool sharking. Jim was a thirty-year fiber optics engineer whose inventions and innovations changed the high reliability interconnect industry. Jim made many lasting friendships with colleagues both at Glenair and throughout the industry. He is missed perhaps as much by his professional colleagues as by his wife, Susan, and children, Terra and Trevor.

Christopher J. Toomey
President

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