SERIOUS Interconnect Cable CAPABILITIES

Mario Trevino, Glenair Complex Cable Group
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Military, aerospace, and harsh-environment industrial interconnect applications require EWIS cabling of a caliber not generally found on consumer-grade applications such as desktop computers or automobiles. In fact, the typical interconnect cable assembly made for high performance applications—from fighter jets to dismounted soldier systems—has little in common with their more pedestrian cousins in the consumer product arena including better shielding from electromagnetic interference, higher levels of environmental sealing and superior all-around mechanical performance.

- Lightweight Mighty Mouse 806 SWAMP zone sensor/transducer interconnect cable assemblies
- Lightweight, flexible, abrasion-resistant power and data cables for soldier C4ISR hubs
- Multibranch overbraided Nomex® cable assemblies with overmolded connector junctions
- Miniaturized space-grade harness assemblies
- High-speed fiber optic in-flight entertainment cable jumpers
- High-temperature tolerant reusable wire-protection conduit assembly for space launch applications
- High-density power connector cables for extreme environments
Glenair: Where Connector Manufacturing Meets Cable Harness Assembly

If there is one thing we understand well at Glenair, it’s how to build interconnect assemblies for high-reliability systems. In fact, when it comes to protecting both electrical and optical media from mechanical stress, corrosion damage, lightning strike, physical abuse, nuclear, biological or chemical contamination and more, there is no more experienced cable operation in the business than Glenair. In large part this is due to our extensive interconnect component design and manufacturing capabilities combined with our many years of experience in military grade and harsh environmental commercial cable harness fabrication.

This issue of QwikConnect presents a comprehensive overview of the interconnect environments, materials and design regimens that go into building high-reliability cable and conduit assemblies that meet even the most stringent electrical, mechanical and environmental performance requirements. The montage below illustrates the many application environments where Glenair interconnect cable assemblies have proven their value and performance since 1956.
Environmental and Mechanical Stress Factors that Impact Cable Design

Application environment and user mechanics define the stress factors a cable or harness must endure. “Build to print” specifications typically spell out cable assembly sealing levels, mechanical durability, shielding levels as well as preferred materials and design. Glenair’s cable/harness engineering team can also suggest design ideas, material types and fabrication processes that we know from experience best meet application needs in each specific environment. Careful attention to caustic chemicals and fuel types, UV exposure and mechanical...
abrasion can significantly improve cable durability. Shielding material choices that resist windowing can improve electrical grounding throughout the life of the system. The judicious use of specialty fabrication processes, such as overmolding and the banding termination of shields, result in robust cable strain relief and reduced stress on wire junctions.

**High-Speed Performance Requirements**

High-speed protocol specifications also dictate material and design decisions for wires, cables, connectors, shielding, and grounding. In specialty cable assemblies, such as RF, gigabit Ethernet and high-bandwidth fiber optics, these many unique requirements demonstrably impact harness design and construction including length, shielding layers, and bend moment. Glenair is well known as the go-to supplier for assemblies of this type. Our complete control of component part manufacture also allows us to offer accelerated lead times, improved quality control, and advantageous pricing on a complete range of assemblies incorporating advanced EMI/RFI filter, lightweight shielding and impedance-control technologies.
**PCB/FLEX Assemblies**

**Printed Circuit Board and Flex Circuit interconnect Assemblies**

Electrical wire interconnect designers are increasingly turning to small form-factor flex circuitry to replace board-to-I/O wiring. Glenair offers turnkey PCB/Flex interconnect design and assembly. PCB/flex circuits offer unsurpassed size and weight reduction compared to cable bundles, especially in tight spaces with multi-branch routing. Flex circuitry offers outstanding mechanical performance, being able to withstand extreme vibration environments and capable of extended duty even through thousands of flexing cycles. Replacing complicated wire bundle assemblies with high-density flex assures faster, error-free assembly.

From concept drawings and fabrication data packages, to PCB/flex fabrication and assembly, we offer a complete solution. Termination to Glenair-manufactured printed circuit board connectors ensures high quality and technical performance to even the most challenging delivery requirements.

The ability to deliver connectorized flex and rigid flex assemblies is an important enabling technology contributing to our overall embedded subsystem electronics offering. We offer IPC Class III manufacturing for multiple panel sizes and panel thicknesses up to .5 inch. A broad variety of materials are available including Polyimide, FR-4, Rogers 4003, and Isola. Available surface finishes include ENIG, HASL, Ni/Au and more. Our PCB/Flex Interconnect team offers:

- Circuit design and generation of PCB/Flex fabrication data packages
- Full component-level documentation
- Top-level assembly drawings and BOM management
- 200+ certified PCB and cable assemblers
- IPC-6012 Class I, II, III, types 1–4; ISO 9001, AS9100
- ESD management
- NADCAP certification for special processes
- Tests such as DWV/IR, continuity, and others.
- Overmolding with multiple materials, including Hysol for PCB terminations
Multibranch Flex and Rigid Flex Connectorized Assemblies

Our flex fabrication cell delivers IPC 6012 and 6013 Class III manufacturing and is managed under the same ISO 9001 and AS9100 certified quality system as the rest of the Glenair operation.

Multibranch factory demo rigid flex assembly highlighting the broad range of catalog board and mezzanine connectors available from Glenair.

Space-grade Micro-D flex assembly with NASA EEE-INST-002 screening and outgassing.

High density .025” contact center nanominiature multibranch flex assembly.

Multibranch RJ45 / Ethernet / USB Flex assembly. Glenair is the only manufacturer of catalog PCB-tail field RJ and USB connectors.

Micro-D subminiature multibranch flex assembly—a Glenair specialty.

Hybrid flex/rigid multibranch assembly ready for connector termination.

Stacked Micro-D I/O connectors with flex jumper to rigid PCB assembly.
Glenair manufactures every mission-critical fiber optic interconnect system and can integrate these fiber optic connectors, termini, backshell accessories, and cables into turnkey assemblies—terminated, tested, and ready for immediate use. Examples shown below range from inside-the-box pigtail assemblies to harsh environmental fiber optic cables, junction boxes, and integrated assemblies.

Environmental overmolded fiber optic cable assembly, MIL-DTL-38999 type with 29504/8 /9 QPL termini

Turnkey catalog ASAP fiber optic cable assembly

Available cable reels and field-deployment technologies including man-packable units for both Glenair GFOCA and Eye-Beam® GMA fiber optic systems

Fiber optic multibranch assembly with flexible conduit wire protection and integrated cable storage bay

High-speed video fiber optic switch and cable junction box assembly

GFOCA I/O to board assembly with reinforcing overbraiding

Demo assembly illustrating MT fiber optic board terminations

Simple inside-the-box MIL-DTL-38999 type I/O connector to board

High-density non-environmental fiber optic assembly

Multi-way inside-the-box D38999-to-ST assembly

FIBER OPTIC Assemblies

Qwik Connect
Fiber Optic Cable Assembly Application Checklist

Application Specifications

Working Environment
- Shipboard
- Airframe / Avionics
- Field Communications
- Space
- Missile Defense
- Other

Cable Installation
- Outdoor
- Indoor
- Internal-to-Equipment

Temperature Requirements
Operating: 
- °C=_____ +°C=_____
Storage: 
- °C=_____ +°C=_____

Optical Fiber Requirements

Singlemode
Number of fibers _______
Fiber Size
- 9/125 µm
- Other
Test wavelength
- 1310 nm
- 1550 nm
Acceptable optical dB insertion loss
- Less than 1.0 dB
- Less than 1.5 dB

Multimode
Number of fibers _______
Fiber Size
- 50/125 µm
- 62.5/125 µm
- 100/140 µm
- Other
Test wavelength
- 850 nm
- 1300 nm
Acceptable optical dB insertion loss
- Less than .5 dB
- Less than 1.0 dB

Cable Harness Construction

Assembly Length Requirements
- Less than 10 Meters
- 10 to 150 Meters
- More than 150 Meters

Cable Type
- Buffered
- Simplex
- Distribution
- Breakout

Basic Harness/Assembly Description
- Open Wire Harness
- Repairable/Jacketed
- Overmolded
- Metal/Fabric Overbraided

Alternative Wire Protection Media
- High Flexibility Convoluted Tubing
- EMI/EMP Metal-Core Conduit
- Molded Shrink Boots
- Junction Box / Cable Bay

Level of Environmental Protection
- Not Applicable
- Moisture Resistance
- Full Water Immersion
- Caustic Fluid Resistance
- Intense Atomic Radiation
- RoHS Compliant Materials
- Extreme Temperature Tolerance
- UL94-VO Flammability
- UV Resistance
- Field Repairability
- Weight Reduction

Connector Types
- Jam Nut or Square Flange or Plug
- Pin Skt Genderless
- D38999 Series III Type
- Glenair High Density Series 80 Mighty Mouse
- Eye-Beam™ GMA GLT
- Glenair Front Release
- MIL-PRF-64266 (NGCON)
- GFOCA
- MIL-PRF-28876
- Termini Part No.________

Dust Cover: 
- Yes
- No

For inside-the-box assemblies indicate B Connector type
- ST Connector___________
- FC Connector___________
- SC Connector___________
- SMA Connector___________
- LC Connector___________
- Other_________________
Glenair STAR-PAN™ USB hub and power distribution interconnect systems are optimized with embedded power conditioning and charging electronics which allow the hub to utilize both primary battery power as well as scavenged power from direct current sources such as transport vehicles and alternative energy sources like kinetic and solar energy. Dedicated adapters and cabling for all charging functions as well as interconnect cabling for the broad range of soldier peripherals, radios, and computer EUDs are also supplied. Glenair STAR-PAN™ system cables utilize field-proven Mighty Mouse Series 804 connectors, and are optimized for durability, flexibility, and environmental sealing.

General-Purpose STAR-PAN™ System Cables

**NETT Warrior (C1) Extension Cable 808-047**

**Host USB-A Cable 808-079**

**C4 Micro USB EUD Host Cable 808-046**

**STAR-PAN™ Peripheral Device Cables**

**TacROVER-e Cable 808-043**

**Radio Adapter Cable 808-080**

**USB 2.0 Adapter Cable 808-053**

**DAGR GPS/Navigation Cable 808-040**

**TacROVER-p ISR Receiver Cable 808-045**

**PLRF-15C/25C Laser Range Finder Cable 808-049**

**STAR-PAN™ Radio Data / Power Cables and Adapters**

**Microlight Radio Data Cable 808-044**

**PRC-117G Radio Data Cable 808-035**

**Harris Radio Adapter Cable 808-088**

**PRC-148 Radio Data Adapter 808-039**

**PRC-152A Radio Data Adapter 808-032**

**PRC-154 Rifleman Radio Data Adapter 808-051**
Small form-factor tactical soldier interconnect cable assemblies with Series 804 Mighty Mouse quick-disconnect connectors

**Harsh Environment Overmolded**

- Overmolded breakout assembly featuring 100% Glenair content; a true turnkey solution
- Multibranch cable assembly with Glenair Mighty Mouse, HiPer-D M24308 and customer-supplied power connector
- Turnkey overmolded GPS cable assembly with integrated switch
- Environmental cable with Glenair Series 804 Mighty Mouse, Series 79, and RF Coax terminations

**Ultraflexible Fabric Overbraid**

- Non-environmental aircraft cable with integrated circuit breakout box and Mighty Mouse 804 push-pull connectors
- Heads-up display (HUD) cable with custom Series 804 Mighty Mouse and low-profile cable routing
- Military jet jumper cable with user-serviceable backshells and fabric overbraid for mechanical protection
- Hybrid Mighty Mouse and Micro-D aircraft pilot helmet cable assembly
TOP 25 CLASSIC POP ALBUMS

Of All Time?

Hey, you can argue all you want… but these are our picks, and we’re sticking with ‘em. How many can you guess with just a postage stamp-sized piece of each original cover?

Answers posted August 15th: www.glenair.com/qwikconnect
Advantages of Overmolding

• Waterproof sealing
• Robust mechanical protection
• Permanent protection of terminations
• Resistance to chemicals and fuels
• No induced cold flow stress
• Electrical isolation and insulation
• Reduced damage from wear
• Flexible routing/cable entry
• Repeatable assembly performance

Terminated, tested, overmolded, and ready for use, Glenair environmental cable assemblies may be supplied with MIL-M-24041 materials as well as other molding materials including Viton®, Duralectric™, polyurethane, EPDM, Santoprene™, polyamide and more. Fast turnaround and quality fabrication in overmolded cable assemblies depends on capital investment in tooling and injection molding equipment. Glenair operates the largest and most well-equipped overmolding shop in the high-reliability cable industry.
Overmolded Cable Assembly Application Checklist

Working Environment:
- Shipboard
- Airframe/Avionics
- Secure Communications
- C4ISR Soldier System
- Armored Vehicle
- Rail/Mass Transit
- Space
- Missile Defense
- Industrial
- Down Hole/Oil Patch
- Other

Basic Physical Description:
- Single-Ended
- Double-Ended
- Multi-Branch
- Overall Length_______
- Dimensional Tolerance \( \pm \) ____ %

Electrical Wire Description:
- Number of Conductors_______
- Conductor Material/Finish_______
- Insulation Material_______
- Wire Gage(s)_______ AWG
- Wire Voltage Rating_______
- Twisted Pair
- Shielded Twisted Pair
- Coaxial

Over EMI/RFI Shield Requirements:
- Single Shield, Standard Coverage
- Double Shield, Maximum Coverage
- Other

Protective Jacketing Material:
- General Purpose Polyurethane
- Low-Smoke, Zero Hal Duralectric\textsuperscript{TM}
- Chemically Resistant Viton
- High-Flexibility Neoprene
- Other

Hybrid Optical/Electrical
- Multiple Conductor Cable
- Other

Optical Fiber Requirements:
- Number of F/O Lines_______
- Single-Mode
- Multi-Mode
- Acceptable Optical dB Loss
  - \(< 1.0 \) dB
  - \(< 1.5 \) dB

Environmental Requirements:
- Full Water Immersion
- Chemical/NBC Resistant
- Advanced Corrosion Protection
- IP67

High-Speed Serial Data Applications:
- 10/100BASE-T
- 1000BASE-T
- USB 2.0
- IEEE 1394

Special Considerations:
- Space-Grade
- RoHS Compliant Materials
- Extreme Temperature Tolerance
- UL94-VO Flammability
- UV Resistance
- Crush/Abrasion Resistance

Identification Method:
- Heat Shrink Band
- Nylon Band
- Hot Stamp
- Other

Electrical Tests:
- Hi-Pot VAC
- Insulation Resistance
MARINE/SUBSEA Assemblies

High pressure, up to 10K psi open-face deep water connectors, complex cables, and PBOF assemblies

All connectors and assemblies fully tested and qualified in-house in Glenair’s state-of-the-art hydrostatic test lab.

Series 70 SeaKing™
10K PSI / 700 Bar / 7000m open-face or mated, dual O-ring equipped, high-density, high-voltage, fiber optic and hybrid electrical/optical subsea connectors.

SeaKing is an innovative new connector series that eliminates a broad range of mechanical design weaknesses found in many of today’s high-pressure subsea connector families. From its double O-ring seals and retractable engaging nut, to its multi-keyed mating interface, the SeaKing represents a bold new approach to subsea power and signal connectivity.

Glenair’s hydrostatic test lab control room: modular consoles provide for up to 8 pressure circuits, operating in manual or automated mode. Each circuit is capable of a maximum of 16.5K psi.

SuperG55 series cables undergoing qualification testing

Glenair’s hydrostatic test lab accommodates pressure testing of discrete connectors as well as large multibranch assemblies

Transparent overmold test sample shows Glenair’s harsh-environment, high-pressure cable overmolding and termination expertise (no voids, 360° material adhesion and cosmetic perfection)

Special high-speed application 10K psi overmolded 75 Ohm Coax hybrid assemblies

SeaKing™ PBOF hose attachment accessories feature adjustable hose routing/angle adjustment and 340° hose swivel action
Series 22 Geo-Marine®

Geo-Marine® plugs are equipped with arctic coupling nuts—made from marine-grade naval bronze—with easy-to-grip castellated knurling and a powerful ratcheted anti-decoupling mechanism which guarantees reliable mating and demating performance in even the harshest environments. Supplied as discrete connectors—or more typically in build-to-print overmolded cable assemblies—the Series 22 Geo-Marine® has delivered reliable, proven performance in high-pressure subsea applications.

SuperG55™

The SuperG55™ family of dry-mate deep sea-high pressure connectors is a revolutionary new design of the popular industry-standard used in countless ROV, underwater camera, diver communications, lights, pan and tilts, and other subsea applications.

Available in multiple shell sizes, the SuperG55™ is manufactured from 316L Stainless Steel with insert molded contact assemblies designed for pressure-sealed applications up to 10K psi mated and unmated. Intermateable and intermountable with other “55” series connectors, the Glenair solution introduces a long list of product innovations designed to improve performance and durability.
Turnkey Wired Conduit Interconnect Assemblies

Many of the conduit and convoluted tubing systems we fabricate at Glenair are assembled at our factory with tamper-proof crimp ring or solder terminations. User-assembled conduit components offer the convenience and flexibility of do-it-yourself field termination—especially valuable for prototyping of interconnect wire protection systems. But reduced size and weight factory terminated assemblies—from simple point-to-point to elaborate multibranch assemblies—offer the utmost in convenience, value, reliability and durability.

Labor-saving, ruggedized and lightweight

• Glenair can design, build, terminate—and even pre-wire—turnkey conduit wire routing solutions.
• Save space, weight, assembly time and labor cost.
• Certified factory assemblers and calibrated tooling for guaranteed performance.
• Simple point-to-point or complex multibranch.

Glenair’s expertise in wired conduit systems extends from simple point-to-point jumpers to complex multibranch assemblies (right) as well as turnkey integrated systems and LRUs with flexible conduit interconnect cabling.
Wired Conduit Assembly Application Checklist

Assembly Type
- Metal core
- Polymer core

Working Environment
- Shipboard
- Aircraft
- Secure Communications
- Ground Support
- Rail/Mass Transit
- Space
- Missile Defense
- Telecommunications
- Armored Vehicle
- Other

Assembly Length Requirements
- Less than 10 Meters
- 10 to 150 Meters
- More than 150 Meters

Special Requirements
- Weight Reduction
- Low Smoke/Zero Halogen
- UL94-V0 Flammability
- CBRN Resistance
- Field Repairability
- Size or Shape Restraints as Specified:

Level of Electromagnetic Protection
- Not Applicable
- db from ________ MHz/GHz to ________ MHz/GHz
- EMP
- TEMPEST
- Other; Required attenuation and frequency band:

Level of Environmental Protection
- Not Applicable (indoors)
- Moisture Proof
- Splash Proof
- Full Water Immersion
- Chemical/Caustic Fluid Resistance
- Extreme Corrosion Resistance

Mechanical Requirements
- Abrasion Resistance
- Crush Resistance
- Approx Strength:
- Flexibility
- Approx number of cycles:
- Tensile Strength
- Max. lbs. of pull:

Temperature Tolerance:
- Operating: - ________ °C to + ________ °C

Storage: - ________ °C to + ________ °C

Mechanical Durability
- Not Applicable
- Light Duty
- Medium Duty
- Heavy Duty

List the connectors used in this project:

List preferred jacketing, protective overbraiding or fabric sheathing materials such as neoprene, Dacron, AmberStrand®, ArmorLite™, and so on.

Marking/Labeling Requirements

Multibranch demo assembly: left: stainless steel metal-core overbraided; middle: polymer-core abrasion protection; and right: high-temperature, halogen-free PEEK

Turnkey integrated box assembly and wired polymer-core interconnect system with NAVSEA-qualified Navy junction boxes.
Rectangular connectors deliver optimized interconnection of circuits with higher-density and less wasted space compared to circulars. Efficient use of space goes hand-in-hand with contact density to enable rectangular shaped connectors to better fit into reduced size and weight applications. Because of their overall shorter length, lower shell profile and the fact that rectangles do not need as much adjacent space for manual mating and de-mating, they are typically the connector of choice for low profile devices such as backplane and blade-type applications.

Glenair manufactures the complete range of rectangular connectors and connectorized interconnect assemblies from Nano and Microminiature to larger form-factor M24308 D-Subs and filtered ARINC 400 / 600.
HiPer-D, Micro-D, Nanominiature, and Series 79 Interconnect Assemblies: Factory-Terminated and Ready for Immediate Use

- Multibranch Micro-D / Mighty Mouse cable assembly with ArmorLite™ lightweight EMI shield overbraiding
- Viton overmolded Micro-D to Mighty Mouse cable assembly with Series 77 Heat Shrink 3-1 transition
- Multibranch Micro-D cable assembly with Dacron overbraid and environmental backpotting
- Repairable backshell-equipped Micro-D open loom cable assembly with MIL-DTL-28840 circulars for a US Navy application
- EMI/RFI shielded multibranch Micro-D connector assembly with Glenair Series 23 SuperNine® panel mount I/O connector
Glenair’s Complex Cable Group (CCG) has delivered creative engineering, high-quality workmanship, fast response, and on-time delivery to countless mission-critical interconnect customers for over 60 years. The operation—from cable design through fabrication, test, and delivery—is fully integrated into Glenair’s Glendale campus, ISO 9001 and AS9100 quality system, and high availability business model.

- High-speed production overmolding
- Commander Ed White’s “Golden Umbilical,” with space-grade radiation shielding
- Reliable Band-Master ATS® EMI/RFI shield termination technology used extensively throughout the shop
- Continuity testing standard on all cable circuits
- CCG manufacturing engineering team designs and builds custom jigs and fixtures
This complex cable assembly is a unique combination of electrical wiring, hydraulic coolant hoses, and pressurized air lines integrated within a pair of articulated aluminum frames. The entire system, including coolant hoses, is assembled and tested according to customer specifications.

- Creative and practical: layout boards ensure final fit and function
- Skilled technicians produce made-to-measure multi-branch assemblies to exact dimensional tolerances
- Complete coverage of cable interstices in overbraided assemblies
If not, why not?

We like to keep things simple at Glenair. I was reminded of this the other day when an ISO quality auditor questioned me regarding customer satisfaction and quality. He was interested in how well we communicated our quality policy throughout our organization and whether or not we took adequate steps to truly evaluate customer satisfaction. My answer was that we use comprehensive PPM measurement instruments and are of course subject to intense scrutiny and feedback from our customers when it comes to on-time delivery, rejected parts and so on. Further, that we deliver important quality training on a regular basis and reiterate quality goals and objectives regularly in employee communications. Nailed it, right?

Some of you may know that our Glendale headquarters is located adjacent to The Disney Company’s west coast Imagineering facility and that over the years we have had the occasion to interact closely with many of the people there. This question of measuring customer satisfaction—measuring it in a way that truly reveals how you are doing—reminds me of the unique approach followed by Walt Disney himself during the early years of Disneyland. Walt had a simple and effective way of determining customer satisfaction, as well as for determining where to focus his ongoing improvement efforts.

At the end of each day, a cheerful cast member with a clipboard would ask departing guests a few simple questions (I’m paraphrasing here, but the most important question in my mind went something like this):

- Do you intend to recommend a trip to Disneyland to your friends, neighbors, co-workers, and others—and if not, why not?

Walt believed a practical survey of this sort would provide all the information needed to determine whether or not they had a customer satisfaction problem. The “if not, why not” element of the question was of course critical. If the reasons were things like, “the lines were too long,” or “the cast members were inattentive,” or “the food was unappetizing,” then voila he had a simple—and practical—road map for corrective action.

I think at times we all believe business must be more complex than that. That particularly in our industry, the range of questions and “if not, why not’s” are more complicated than in Walt’s day. But really, doesn’t this one issue go straight to the heart of quality, performance, and customer satisfaction? In fact, what better way to gauge for yourself on an ongoing basis—no matter what your role is in the organization—whether your specific performance is meeting your customer’s expectations? I can’t say whether Walt’s approach would have won any points with an ISO audit team. But I do hope it gives everyone on the Glenair team a glimpse into a powerful and effective way to truly measure customer satisfaction.

Chris Toomey