DEEP DIVE: Glenair Subsea Interconnect Technologies

ROVs: The Workhorse of Subsea Science and Exploration

Small unmanned submersibles called “marine remotely operated vehicles” or ROVs are deployed throughout the oil & gas industry—and in other industries such as scientific research, fisheries and aquaculture, oceanography, underwater archaeology, ocean exploration, and military defense—to perform inspection, repair, and maintenance functions in water too deep or too dangerous for divers. ROVs service sea floor drilling and processing operations with capabilities as diverse as trenching and drill support. The various classes of ROVs are distinguished by their size, maneuverability, methods of propulsion. Regardless of class, all ROVs are cable connected (tethered) to their support platform. In addition, ROVs share two key characteristics: a subsea-to-topside visual feed (typically an HD/SD TV which provides real-time subsea-to-topside visual feed (typically 270 and 240 VDC full wave rectification of 120/208 VAC power requirements the industry is now adopting in the case of larger work-class ROVs, a separate assembly which sits on top of the ROV. The purpose of the TMS is to lengthen and shorten the tether as needed so that the cable drag effect of underwater current is minimized. The umbilical is an armored cable that contains a group of electrical conductors and fiber optics that carry electric power, video, and data signals between the operator and the TMS. Some umbilical tethers are equipped with pneumatics to power work-class ROV equipment. Where used, the TMS then relays the signals and power for the ROV down the tether cable to power sensors, magnetometers, still cameras, manipulators, water samplers, cutting arms, or scientific instruments that measure water clarity, temperature, density, sound velocity, and light penetration.

During operation ROVs are linked to a host vehicle by a neutrally buoyant tether, or, when working in rough conditions or in deeper water, a load-carrying umbilical cable is used along with a tether management system (TMS). The TMS is either a garage-like neutrally buoyant tether or, when working in rough conditions or in deeper water, a load-carrying umbilical cable is used along with a tether management system (TMS). The TMS is either a garage-like or, when working in rough conditions or in deeper water, a load-carrying umbilical cable is used along with a tether management system (TMS). The TMS is either a garage-like or, when working in rough conditions or in deeper water, a load-carrying umbilical cable is used along with a tether management system (TMS). The TMS is either a garage-like device which contains the ROV during lowering through the splash zone or, in the case of large work-class ROVs, a separate assembly which sits on top of the ROV. The purpose of the TMS is to lengthen and shorten the tether as needed so that the cable drag effect of underwater current is minimized. The umbilical is an armored cable that contains a group of electrical conductors and fiber optics that carry electric power, video, and data signals between the operator and the TMS. Some umbilical tethers are equipped with pneumatics to power work-class ROV equipment. Where used, the TMS then relays the signals and power for the ROV down the tether cable to power sensors, magnetometers, still cameras, manipulators, water samplers, cutting arms, or scientific instruments that measure water clarity, temperature, density, sound velocity, and light penetration.

Interconnect Technology for ROVs

ROVs are the backbone of all deepwater offshore exploration and production activities. They perform installing assets and bringing wells online, to the complex business of decommissioning end-of-life fields. ROV equipment sets are pressure resistant, making it possible for the submersible to function and operate in harsh and remote depths up to 10,000 feet. In the demanding deep-water operations environment, electrical engineers specifying interconnect technology must consider extremes in temperature, pressure, and corrosion when choosing appropriate cable and connector sets to bring power and data to equipment and tools. Connectors must be evaluated for mating durability and wire-to-connector termination durability by considering working conditions including cathodic depolarization corrosion due to dissimilar metals, and mechanical stress due to cable routing and wave action.

Pressure resistant connectors are required on all ROVs for electrical and optical circuits interconnecting payload components and/or umbilical connectivity topside. 10 kpsi is the standard for ROV connectors. Connectors typically employ front-end sealing technology that allows for wet underwater mating (not currently supplied by Glenair) and/or open-face exposure of connector halves to subsea pressures (a major Glenair achievement in our revolutionary SeaKing connector series later in this special edition of QwikConnect). Back-end sealing technology protects the termination zone for both cable and contact, and is often a weak point in connector and cable sealing. Glenair brings over 60 years of marine-critical sealing expertise to our subsea interconnect designs, including deep materials science fluency in elastomers such as polyurethane and neoprene. Various other techniques and materials are available for front-end and back-end-to-cable sealing in subsea interconnects including:

Connector Sealing Technologies
- Glass-to-Metal
- Welding/Brazing
- Metal-to-Metal Seals
- Rubber-molded connectors
- Needle valves
- Tapered threads
- Potting/Adhesive/Sealants
- O-rings

O-rings are the unsung hero of sealing, and when properly applied can yield reliable, high pressure sealing results. O-rings are small, cheap, suitable for high-mating cycle applications, easy to inspect, easily serviced and, as mentioned, extremely effective when proper attention is applied to engineering best-practices. These practices focus on gland design (the relative advantages and disadvantages of axial face seals compared to radial piston or rod seals), as well as careful attention to metal-to-metal extrusion gaps, and O-ring groove widths.
Connector series were originally designed for shallower, lower pressure applications with shorter deployments. But today’s requirements for 10k-psi high-pressure performance and deployments measured in weeks, not hours, call for both better mechanical design and harder 90 Shore-rated seals.

Many subsea applications utilize electrical and optical Pressure Balanced Oil Filled (PBOF) cables. PBOF cables use a compensating fluid-filled elastomeric tube as a conduit for the electrical and fiber optic lines. The elastomeric conduit allows the ocean pressure to transfer to the compensating fluid, equalizing the pressure differential.

PBOF technology has been widely utilized in ocean science exploration, drilling systems, production control systems, towed sonar arrays, and most importantly, for the interconnection of subsea floor structures and equipment. Special PBOF connectors are employed to enable the ROV to connect and disconnect flying lead PBOF cables for maintenance or equipment replacement.

Glenair has developed a superior PBOF technology design that allows for faster, easier assembly and ease-of-repair in the field, and the utilization of both straight and sweeping, non-constricting 45° and 90° elbows. These improvements and a host of others are now available in Glenair SeaKing high-pressure connectors and coming soon in our revolutionary SuperG55 series. The SubSea/Marine Team at Glenair invites you to enjoy the rest of this special edition of QwikConnect and to contact the factory for applications and design-in support.

Next to mechanical design, the proper application of materials science has the greatest impact on high-pressure sealing. Metallic and non-metallic materials must be evaluated for temperature extremes, fluid compatibility, abrasion resistance, gas decompression, and conductivity. Shore hardness is a particularly critical material selection criterion in high-pressure sealing applications as it directly impacts material performance under pressure. Extrusion gaps in the designed clearance between metal sub-assemblies, for example, can be problematic for O-rings with Shore hardness ratings under 90. Many legacy subsea equipment engineers must consider extremes in temperature, pressure, and corrosion when choosing subsea connectors. The ROV’s size and duty range can also influence connector choice. Glenair’s dedicated subsea engineers can work directly with ROV payload designers to select the best interconnect for the application.

[Diagram of ROV payloads]

**ROV Payloads**

The equipment that ROVs use to perform their underwater work is known as the “payload.” An ROV’s payload could include sonar, lights, video cameras, gyroscopes, navigation systems, thrusters, manipulators (robotic arms) and occasionally, still cameras and strobes. All of these devices require interconnection to power supplies, communication systems and controllers. Subsea equipment engineers must consider extremes in temperature, pressure, and corrosion when choosing subsea connectors. The ROV’s size and duty range can also influence connector choice. Glenair’s dedicated subsea engineers can work directly with ROV payload designers to select the best interconnect for the application.
Hydrostatic test lab

The Glenair marine/subsea technology team is unique in the industry having the ability to design, produce, validate, and test its complete range of subsea interconnect technologies using 100% in-house resources. Glenair’s hydrostatic lab is a dual-mode pressure test facility equipped with both large form-factor pressure vessels for testing complete cable assemblies, mated cable connectors, and even customer sub-assemblies. In addition, a small pressure vessel cell provides qualification and validation testing on discrete connector inserts and bulkhead connectors. Both the large pressure vessel and small pressure vessel systems can validate and test up to 16.5K psi, or 1 1/2 times Glenair’s standard 10,000 psi subsea connector rating.

DISCRETE CONNECTOR TESTING: All Glenair subsea interconnects are subjected to 100% inspection and test.

LARGE PRESSURE VESSELS: Built to accommodate complete cable assemblies, mated connectors, and customer-supplied sub-assemblies. Each unit contains a 12” diameter X 72” depth test chamber accommodating specimen weights up to 1500 lbs.

TECHNICAL STAFF: Knowledgeable and trained subsea specialists perform both in-house product qualification testing, as well as customer subassemblies.

CONTROL ROOM: The modular consoles in the control room provide for up to 8 pressure circuits, operating in Manual mode or Automated. Each circuit is capable of a maximum of 16.5K psi. Monitors display Automated Test Profiles, Data Acquisition, remote viewing of Test rooms and more. System is network connected for access to Profiles and distribution of test reports.

SeaKing™ and SuperG55™ QUALIFICATION TESTING: Both Glenair Series 70 SeaKing and SuperG55 rugged dry-mate subsea connectors have been tested and qualified to their 10K psi pressure rating—open-face and mated—in Glenair’s state-of-the-art hydrostatic test lab. Additional testing included mating cycles, salt spray, and electrical continuity.

Glenair Hydrostatic Test Lab Technical Specifications and Pressure Test Standards

<table>
<thead>
<tr>
<th>Pressure test profiles</th>
<th>Automated or manual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum test pressure</td>
<td>16.5K psi</td>
</tr>
<tr>
<td>Data acquisition types</td>
<td>Pressure, time, temperature, and electrical performance</td>
</tr>
<tr>
<td>Performance monitoring under pressure</td>
<td>V/I, continuity, insertion loss, and backreflection (optical)</td>
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<tr>
<td>Industry profiles</td>
<td>All major oil &amp; gas standards</td>
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<tr>
<td>Custom profiles</td>
<td>Yes, including customer-supplied subassemblies</td>
</tr>
<tr>
<td>Capacity (large pressure vessels)</td>
<td>Working volume = 12” diameter x 72” depth; Test specimen weight up to 1500 lbs.</td>
</tr>
</tbody>
</table>
Marine/Subsea Interconnect Solutions from Glenair

- High-pressure subsea
- Ruggedized serial and high-speed electrical connectors
- Glass-sealed high-pressure bulkhead feed-thrus
- Fiber optic and opto-electronic solutions
- Hazardous zone ATEX explosion-proof
- Commercial Oil & Gas and defense industry solutions

High-performance, mission-critical interconnect technologies with proven shipboard and subsea performance
**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.

Ideally suited for offshore oil & gas, military/defense, oceanographic research, and other harsh-environment subsea applications, the dry-mate connector series is built for optimal durability and reliability. Tested to 15,000 PSI (open face and mated), and equipped with integrated dual O-ring seals, marine bronze coupling nuts, corrosion-resistant stainless steel shells and high-pressure contact inserts with gold-plated signal contacts, special RF and fiber optic solutions, the Series 70 SeaKing is today’s most advanced high-density signal and standard-density power subsea connector available.

**STANDARD CONFIGURATIONS**

- Cable Connector Plug (CCP)
- Bulkhead Connector Receptacle (BCR)
- Flange Connector Receptacle (FCR)

**Sealing:** The Series 70 SeaKing is the best sealed subsea connector on the market. All critical interfaces, including bulkhead seals, glass-to-metal insert seals, mating interface bore seals, and face seals are fully redundant ensuring 10K PSI protection, even in the event of a single-seal failure.

**Mating:** SeaKing utilizes a modified UNC (coarse) mating interface with added clearance to reduce bio-fouling and facilitate rapid-advance mating. The marine bronze coupler on the plug is equipped with thread flats as well as knurling and is less susceptible to galling than standard steel engaging nuts. Polarized keys and keyways prevent both thread damage and mismating.

**Ease-of-Use:** Multiple PBOF backshell indexing points, indexable flange FCRs, full-mate inspection ports, retractable engaging nuts, and other features make SeaKing the most user-friendly subsea connector on the market.
SeaKing™ CONNECTOR SERIES OVERVIEW

700-001
SeaKing™ Cable Connector Plug (CCP), 10,000 psi rated (mated condition), subsea environment, solder termination

700-006
SeaKing™ Flange Connector Receptacle (FCR), 10,000 psi rated (open face and mated), subsea environment, solder termination, indexable flange

700-007
SeaKing™ Bulkhead Connector Receptacle (BCR), 10,000 psi rated (open face and mated), subsea environment, solder termination

TURNKEY OVERMOLDED AND REPAIRABLE CABLE ASSEMBLIES AND SPECIAL CONFIGURATIONS

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

10K psi overmolded CCP assembly
10K psi overmolded 75 Ohm Coax hybrid assembly
Repairable wire mesh grip-equipped topside CCP cable
Cabled bulkhead connector receptacle (BCR) assembly
FCR assembly with flange mounting points and indexed flange
Special Oil & Gas industry NE 606 overmolded cable

Sealing Performance Specifications

<table>
<thead>
<tr>
<th>Pressure Rating Plug</th>
<th>10,000 psi, mated condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reciprocating 10,000 psi mated and open face</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Electrical</th>
<th>600 V typical</th>
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<tbody>
<tr>
<td>5 GOhm insulation resistance at 50V DC</td>
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</table>

<table>
<thead>
<tr>
<th>Materials</th>
<th>Salt Spray (corrosion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humidity (steady state)</td>
<td></td>
</tr>
<tr>
<td>Thermal Cycle</td>
<td></td>
</tr>
<tr>
<td>MIL-STD-202, Method 101</td>
<td></td>
</tr>
<tr>
<td>MIL-STD-202, Method 102</td>
<td></td>
</tr>
<tr>
<td>ISO 1628-6</td>
<td></td>
</tr>
</tbody>
</table>

| Shock | MIL-STD-202, Method 101 |
| Vibration | MIL-STD-202, Method 102 |

The complete range of SeaKing PBOF hose compression fittings includes straight, 45°, and 90° full radius profile versions; with and without integrated oil fill ports

REVOLUTIONARY PBOF SWIVEL HOSE ATTACHMENT ACCESSORIES

Hose barb fittings for PBOF cable assemblies are the perennial weak link in subsea oil & gas applications. Kinked and twisted hoses, leaky fittings, corroded hose clamps, and general poor performance characterize most existing solutions. The Glenair PBOF swivel hose attachment for SeaKing connectors solves these problems and more. Designed from the sea floor up to perform flawlessly and reliably, this revolutionary attachment puts an end to the long list of field maintenance problems associated with oil-filled cable applications.

- Straight, 45°, and 90° “full radius” angle and profile hose routing
- Hose angle adjustment feature eliminates risk of oil leakage
- Corrosion-resistant materials used throughout
- Threaded couplers with safety set-screws for fail-safe leak and decoupling protection—no special tools required for assembly
- Compact PBOF compression fitting with 340° hose swivel action
- Support for the broad range of hose diameters and wall thicknesses

Interlocking teeth on SeaKing plug connectors interface with corresponding teeth on the PBOF swivel hose attachment to facilitate easy indexing and routing of hose assemblies

Threaded PBOF compression nut and connector coupling nut (with additional safety set screw) provide for fast and easy assembly and prevent leaks and assembly decoupling
The SuperG55 family of dry-mate underwater connectors is a revolutionary new design of the popular industry-standard marine interconnect used in countless ROV, underwater camera, diver communications, lights, pan and tilts, and other subsea applications.

Available in 3 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. Our PBOF versions, for example, utilize easy-to-assemble threaded fittings which deliver both superior sealing performance while reducing installation time. Other innovations include full-mate inspection windows, improved solder cup contact design, improved potting and sealing, and more. Cable plugs and receptacles are available in attachable (user-terminatable) versions or factory oversmolded single-ended whips.

- **10,000 psi mated/ unmated (approx. 22,500ft/7,000m)**
- **Recessed plug socket contacts for safety**
- **Intermateable and intermountable with other “55” series connectors**
- **3 shell sizes — 15, 20 and 24, with 3 to 21 contacts**
- **PBOF versions available**
- **600 VDC, 5 to 18 Amps (dependent on conductor and cable size and make-up)**
- **Retractable, anti-galling coupling nuts prevent misingmat and improve durability**
Fill in the randomly numbered blanks to solve this sea song puzzle

1. ___ th ___ C
2. ___ s ___ a ___
3. ___ k ___ r
4. ___ W ___ d ___
5. (___ ' ___) ___ o ___ y
6. W ___ s/ ___ gg
7. ___ o t ___
8. ___ b ___ m
9. O ___ n
10. ___ b ___
11. ___ t ___ a
12. A ___
13. ___ k _ ___ r
14. ___ y _ e ___ s
15. ___ a ___ a ___
16. ___ e i w ___
17. ___ o o ___
18. ___ e ___
19. h _ r ___ i ___
20. ___ m ___ S

Solution posted November 15th
www.glenair.com/qwikconnect

Bridge:
E C#m7 A
It’s far,
B7 E C#m7 beyond a star
A
It’s near,
C#m7 G7 beyond the moon:
G Em Am7
I know
D7 G Am7 beyond a doubt
A7 D7 My heart
G Gdim Edim G7
will lead me there someday.

G        Gdim   Edim   G7
My heart
G        Gdim   Edim   G7
will lead me there soon.
SERIES 802
AquaMouse
Ultraminiature high-pressure

Originally developed for petroleum pipeline inspection equipment, Series 802 connectors are available in ten sizes from 1 to 130 contacts and equipped with Viton® or Nitrile O-rings to withstand exposure to corrosive chemicals and high temperature environments. These connectors feature high density crimp Mighty Mouse inserts, 316 stainless steel or marine bronze shells and a positive O-ring for hydrostatic sealing. Series 802 insulated wire, panel mount receptacles can be ordered as square flange, in-line or jam-nut versions. Choose integral shield termination platform or accessory thread for use with a variety of strain relief options. Crimp style gold-plated crimp contacts accept #12–30 wire. Connectors are backfilled with epoxy potting compound. Hermetic glass-sealed connectors come with solder cup contacts (non-removable) or PC tails. 100% tested to meet 1 x 10^-7 cc/sec helium leakage. Open face pressure rating 3500 PSI.

3500 psi pressure rated
High-temperature and corrosive chemical-resistant Viton® or Nitrile O-rings
Ultraminiature #23 contacts
Size #20, #20HD, #16, #12, #8 signal, power, fiber optic and shielded contacts
Discrete connectors and turnkey cable assemblies

AQUAMOUSE CONNECTOR CONFIGURATIONS AND CLASSES

Series 802 Plugs
Series 802 BCR
Series 802 FCR
Series 802 Hermetic BCR
Series 802 Hermetic Bulkhead Feed-Through
SERIES GLA 20
Marine Molded Underwater Interconnect Assemblies

Glenair Marine Molded series connectors are used in remotely operated vehicles, underwater lighting systems, underwater video monitoring systems and other subsea applications. Available in both rubber molded cable and inline versions, as well as glass-filled epoxy bulkhead versions, the Marine Molded series is a reliable and cost-effective interconnect technology for high-pressure subsea applications up to 10K psi mated condition. Available in a wide range of high-pressure insert molded contact arrangements, with size #16 to size #0 contacts, and from one to eight circuits.

- 10,000 psi (mated) pressure rating
- 7.5 Amps to 200 Amps
- One to eight contacts
- Catalog and custom cable options
- Chemically resistant

Specifications
- Contacts: Copper Alloy, Gold-Plated
- O-Rings: Neoprene
- Nut, Washer: Stainless Steel
- Cable: Neoprene insulation, Stranded Copper Conductor
- Bulkhead Connector Body: Glass-Filled Epoxy
- Voltage Rating: 600 VDC
- Current Rating: See Contact Arrangements
- Temperature Rating: -55°C to +155°C

Contact Arrangements and Current Rating

1 Contact 2 contacts 3 contacts 4 contacts 5 contacts 6 contacts 8 contacts

1 #10 Contact 20 Amps G1 1 #6 Contact 200 Amps K1 1 #12 Contact 10 Amps G2 1 #12 Contact 3 #16 Contacts 7.5 Amps G4 1 #12 Contact 4 #16 Contacts 7.5 Amps K4 1 #12 Contact 5 #16 Contacts 7.5 Amps K5 1 #12 Contact 7 #16 Contacts 6 Amps K8

ACCESSORIES
Locking Sleeves
Locking Sleeves enable a mated pair of cable assemblies to be locked together, preventing accidental unmating. Material: Delrin.

O-Rings

Male Bulkhead Connector

Female Bulkhead Connector

Neoprene Body
Neoprene O-Ring
Gold-Plated Pins
Solder Cup Pins
Glass-Filled Epoxy Body
Stainless Steel Nut and Washer
Molded O-Ring
Neoprene Jacket
Gold-Plated Socket Contacts
Male Cable Assembly

Male Bulkhead Connector

Gold-Plated Pins
Neoprene Body
Molded O-Ring
Neoprene Jacket
Gold-Plated Socket Contacts
Male Cable Assembly

Female Cable Assembly
**HIGH-RELIABILITY**

Glass-sealed Hermetic Connectors

Resolve gas, moisture and particle ingress problems with advanced-performance glass-sealed hermetic connectors

**VITREOUS GLASS TECHNOLOGY ADVANTAGES**

- Superior pressure resistance to 32,000+ PSI
- Hundreds of designs, including long-length bulkhead feed-thrus and penetrators
- Higher resistance to extreme operating temperatures to 260°+ C
- Superior mechanical strength
- No material breakdown or aging over time
- Helium leak rate <1X10⁻⁷ cc/sec to 1X10⁻¹⁰

**MIL-DTL-38999 AND OTHER**

**Glass-Sealed Hermetic Connectors**

**GEOPHYSICAL AND OFFSHORE CONFIGURATIONS**

- GeoMarine® double-start hermetic connector
- Hermetic power connector
- Single-way tool joint hermetic connector
- Hermetic probe connector
- Hermetic bulkhead penetrator

**HIGH-SPEED/SHIELDED DESIGNS**

- Triax hermetic
- Hybrid coax/signal hermetic
- QuadraX hermetic
- MT ribbon fiber optic hermetic
- Hybrid coax/signal hermetic

**RECTANGULAR PACKAGES**

- MIL-DTL-24308 QPL hermetic
- MIL-DTL-83513 type micro-D hermetics
- Sealed panel-mount micro-D hermetic
- Well-Master™ 260° high-temperature Micro-D

**MIL-DTL-38999 QPL PIN AND SOCKET HERMETICS**

- Series I Scoop-proof 3 Point Bayonet Coupling
- Series II Low-profile 3 Point Bayonet Coupling
- Series III Scoop-proof Triple Start, Self-Locking
- Series IV Scoop-proof Breach Lock

**CIRCULAR GLASS-SEALED HERMETIC CONNECTORS AVAILABLE WITH ACCELERATED LEAD TIMES**

- MIL-DTL-26482
- MIL-DTL-83723
- MIL-DTL-38999 (QPL)
- MIL-DTL-5015 Series 80 Mighty Mouse
- Series 80 Mighty Mouse
High-pressure harsh-environment connectors and overmolded cables for towed array and other high-pressure/submersible applications

Designed for use in oceanographic, geophysical and other severe industrial environments, Glenair Series 22 Geo-Marine® Connectors and Cables are the ultimate harsh-environment power and signal connector solution. Built to withstand hydrostatic pressures up to 5,000 PSI and exposure to extreme temperatures and corrosives, the Series 22 Geo-Marine® is ideally suited for applications such as US Navy towed array sonar systems, military land vehicles, submersibles and ROV’s, offshore-oil drilling equipment, seabed exploration, pipeline inspection systems, well monitoring equipment, and digital seismic streamers.

- 5000 psi pressure rated
- Marine Grade 316 stainless steel machined shells and Naval Bronze coupling rings
- High-pressure environmental and hermetically sealed receptacles for field applications
- Power and signal contact arrangements from 2 to 128 contacts
- Anti-vibration ratcheted coupling nuts with castellated knurling
- Available Viton® overmolded cable assemblies

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.

Range of Offerings
Series 22 Geo-Marine® connectors are supplied with either fused-glass ("H" hermetic class) or high grade thermoplastic ("E" environmental class) insulators. Both classes of connectors are supplied with rugged, corrosion-resistant materials. Low-profile and scoop-proof cable plugs and receptacles, as well as bulkhead feed-thrus are available. Specially-designed cable sealing backshells as well as EMIF1 shield termination backshells and environmentally-sealed protective covers complete the range of discrete product offerings. 35 insert arrangements (contact sizes #12, #16, #20 and #22) are tooled and fully available.

WIDE RANGE OF PLUG CONFIGURATIONS WITH ANTI-GALLING ARCTIC COUPLING NUTS

HIGH-PRESSURE ENVIRONMENTAL AND HERMETIC RECEPTACLE CONFIGURATIONS

RUGGEDIZED STAINLESS STEEL BACKSHELLS AND OTHER CONNECTOR ACCESSORIES
Industrial-strength power and signal connector series qualified for use in hazardous zone interconnect applications

Designed for safe operation in petrochemical refineries, oil & gas drilling platforms, and other explosion zone applications, the Glenair ITS-Ex series connector is optimized for life-of-system durability and reliability. Qualified by the globally-recognized IEC and IECEx standards bodies, the connector series is suitable for use in application areas where flammable gases and vapors are present as a normal condition of operation (group IIC) and with temperature classes T6 and T5, zones 1 and 2; and for applications where potentially flammable dust is present as a normal condition of operation (group IIIC) and with temperature classes T80°C and T95°C in zone 21 and 22.

Series ITS-Ex is designed for easy and repeatable termination of armored and unarmored cables built to IEEE 45, IEC, BS, DIN, and JIC standards. A full range of power and signal contacts, from size #16 to size #0 in over 40 insert arrangements are available to address all common voltage, wire size and connector service class ratings.

Special Ex design attributes of the series include an integral labyrinth flame path cooling zone, 2-part epoxy potting well, fixed in-line receptacles for attachment of cables to cable management brackets and trays, set screw (grub screw) secured protective safety covers, and durable life-of-system Ex marking labels.

- Utilizes all standard features of 5015 inserts, contacts, tools, etc.
- Grub nuts (set screw) to lock coupling nut
- Long plug barrels provide cooling zone
- Labyrinth gas exit port/pathway augments cooling
- Accessory accommodation for potted glands
- Increased wall thickness
- Stainless steel and Marine Bronze available

**RANGE OF APPLICATIONS**

- Automotive refuelling or petrol stations
- Oil & gas extraction
- Oil refineries
- Gas pipelines and distribution
- Chemical processing plants
- Aircraft refuelling and hangars
- Transportation
- Pharmaceuticals
- Food processing
- Metal surface grinding
- Sugar refineries
- Grain handling and storage
- Coal mining
Connectors qualified to the complete requirements of MIL-PRF-28876 including plugs, wall-mount receptacles, jam-nut mount receptacles and in-line receptacles.

- Multiple shell sizes and insert arrangements, including 2, 4, 6, 8, 12, and 31 channel layouts
- Backshells in straight, 45° and 90° configurations
- Corrosion-resistant and environmentally sealed
- Qualified MIL-PRF-29504 and MIL-PRF-28876 fiber optic connection system

Qualified MIL-PRF-28876 fiber optic connectors and MIL-PRF-29504 termini—Navy approved, in stock, and ready for immediate shipment

- Wall Mount Receptacle Types: M28876/1, M28876/2, M28876/3, M28876/4, M28876/5, M28876/6, M28876/7
- In-Line Receptacle Types: M28876/8, M28876/9, M28876/10, M28876/11, M28876/12, M28876/13, M28876/14, M28876/15
- Plug Types: M28876/16, M28876/17, M28876/18, M28876/19, M28876/20, M28876/21
- Jam Nut Receptacle Types: M28876/22, M28876/23, M28876/24

Qualified QPL-29504 pin and socket termini

<table>
<thead>
<tr>
<th>Connector Type</th>
<th>Backshell Type</th>
<th>MIL-Spec Connector Type Code</th>
<th>Commercial Connector Type Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Mount Receptacle</td>
<td>None</td>
<td>M28876/1</td>
<td>03</td>
</tr>
<tr>
<td>Straight</td>
<td>M28876/2</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>45°</td>
<td>M28876/3</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>90°</td>
<td>M28876/4</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>In-Line Receptacle</td>
<td>Straight</td>
<td>M28876/5</td>
<td>15</td>
</tr>
<tr>
<td>Plug</td>
<td>None</td>
<td>M28876/6</td>
<td>06</td>
</tr>
<tr>
<td>Straight</td>
<td>M28876/7</td>
<td>16</td>
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</tr>
<tr>
<td>45°</td>
<td>M28876/8</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>90°</td>
<td>M28876/9</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Jam Nut Receptacle</td>
<td>None</td>
<td>M28876/10</td>
<td>04</td>
</tr>
<tr>
<td>Straight</td>
<td>M28876/11</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>45°</td>
<td>M28876/12</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>90°</td>
<td>M28876/13</td>
<td>34</td>
<td></td>
</tr>
</tbody>
</table>

Qualified MIL-PRF-28876 fiber optic cable assembly

- Connector Types: M28876/2, M28876/7
- With Backshell: M28876/11 jam nut receptacle, M28876/7 plug with backshell

QPL AND COMMERCIAL
MIL-PRF-28876
Fiber optic connection system

- Performance Specifications/Requirements based on the use of MIL-PRF-24792 Epoxy and MIL-PRF-85045 Simplex and Breakout Shipboard Optical Fiber.

- Termination and tested MIL-PRF-28876 fiber optic cable assembly

- Insert Arrangements

- Pin Insert Face
- Socket Insert Face

- Size A or Size 11 Ins. Desig. 1 3 channels
- Size B or Size 13 Ins. Desig. 2 4 channels
- Size C or Size 15 Ins. Desig. 3 6 channels
- Size D or Size 17 Ins. Desig. 4 8 channels

- Test Description Performance Requirements/Specifications

  - Optical Insertion Loss, Multimode: -0.3 dB Typical (62.5/125)
  - Optical Insertion Loss, Singlemode: -0.3 dB Typical (9/125)
  - Optical BackReflection, Singlemode: Better than -40 dB -PC Polish -Better than -50 dB -Enhanced PC Polish
  - Operating Temperature: -28°C to +65°C (MIL-Spec Epoxy and Cable) -55°C to +125°C (alternative Epoxy and Cable)
  - Temperature (Thermal) Shock: -40°C to +70°C, 5 Cycles
  - Temperature/Humidity Cycling: -10°C to +65°C, 10 Cycles, 240 hours, 98% RH
  - Temperature Cycling: -28°C to +65°C, 5 Cycles
  - Temperature Life Aging: +110°C, 240 hours, Dry Air
  - Vibration - Sinusoidal: 10 g Peak, 5-550 Hz sin./ 10 g RMS, 50-2000 Hz random
  - Impact: 8 Drops from 8 feet
  - Crush Resistance: 201 lbs, 7 Cycles
  - Cable Pull Out Force - Termini: 32 lbs for 6 minute
  - Fluid Immersion: Turbine Fuel, Isopropyl Alcohol, Hydraulic Fluid, Lubricating Oil, Coolant, Tap- and Seawater, 24 hrs
  - Water Pressure: 32 lbs for 48 hours at +10°C to +30°C
  - Mechanical Shock (High Impact): MIL-S-901, Grade A, Type B, Class I
  - Corrosion Resistance (Salt Spray): 150 hours
  - Sand and Dust: 12 hours
  - Flammability: 0.75 inch flame for 10 sec; melted, 150 inch flame for 60 sec, unthinned

- MIL-PRF-29504/14-4131C 126.0 Multi Mode
- MIL-PRF-29504/14-4132C 127.0 Multi Mode
- MIL-PRF-29504/14-4133C 128.0 Multi Mode
- MIL-PRF-29504/14-4134C 129.0 Multi Mode
- MIL-PRF-29504/15-4171C 126.0 Multi Mode
- MIL-PRF-29504/15-4172C 127.0 Multi Mode
- MIL-PRF-29504/15-4173C 128.0 Multi Mode
- MIL-PRF-29504/15-4174C 129.0 Multi Mode
- MIL-PRF-29504/15-4175C 127.0 Multi Mode
- MIL-PRF-29504/15-4176C 128.0 Multi Mode
- MIL-PRF-29504/15-4177C 129.0 Multi Mode
- MIL-PRF-29504/15-4178C 127.0 Multi Mode
- MIL-PRF-29504/15-4179C 128.0 Multi Mode
- MIL-PRF-29504/15-4180C 129.0 Multi Mode
- MIL-PRF-29504/15-4181C 127.0 Multi Mode
- MIL-PRF-29504/15-4182C 128.0 Multi Mode
- MIL-PRF-29504/15-4183C 129.0 Multi Mode
Fiber Optic Interconnect Solutions

Unlock the huge bandwidth of fiber optic connectors, cables, and ruggedized transceiver technologies

Glenair harsh-environment fiber optic connectors and board-level transceiver technologies are designed for harsh land, air, sea, and space environments and will operate reliably over very wide temperature ranges and high shock and vibration conditions. These proven technologies have been optimized to minimize size, weight and power and offer electrical-to-fiber conversion for Ethernet, video, signal aggregation and high-speed digital signals. Glenair also offers integration of electronics or opto-electronics into rugged connector packages and cable assemblies per specific customer requirements. We offer rapid response in-house electrical/PCB design, and mechanical connector/backshell engineering from our vertically integrated factory.

GLENAIR FIBER OPTICS

- Reduced size, weight, and power consumption
- Total EMI immunity, network security, increased transmission distance and ultra-high bandwidth
- High shock and vibration to support mission critical applications
- Wide operating temperature range: -40°C to +85°C and beyond
- Qualified, proven opto-electronic and fiber optic interconnect technologies for both commercial oil & gas and naval/defense applications.

HARSH-ENVIRONMENT FIBER OPTIC CONNECTORS AND OPTO-ELECTRONIC TRANSCEIVERS

- Opto-electronic transmitter and receiver contacts for Ethernet, video, and high-speed data
- High vibration and shock board-mount transmitters and receivers with Samtec surface-mount connectors
- EMI shielded PCB transceiver showing Samtec surface-mount connector and Glenair GC F/O interconnects
- Harsh-environment opto-electronic connectors for Ethernet, video, and high-speed data
- MIL-PRF-28876 US Navy qualified fiber optic connectors and termini
- Eye-Beam® GMA Expanded-Beam
- Eye-Beam® GLT Expanded Beam Fiber Optic

Small form-factor transceiver
Signal aggregation media converter
7-port Ethernet switch
DVI video media converter

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Good Ideas

The founder of the Dayton Engineering Laboratories Company, the outfit that was to become Delco, was a man by the name of Charles Kettering. That’s his picture there on the cover of Time magazine. Kettering was an American inventor, engineer, businessman, and the holder of 186 patents. In addition to his work at Delco, he was head of research at General Motors from 1920 to 1947. Kettering was renowned for the practicality of his inventions. As he said, “I didn’t hang around much with…the executive fellows. I lived with the sales gang. They had some real notion of what people wanted.”

Early automobiles required a hand crank for starting. Occasionally, when the spark lever was not properly set, the hand crank kicked back, causing serious injury: a broken wrist, arm, or shoulder. On a winter night in 1908, the result was much worse. Byron Carter, founder of Cartercar, came across a stalled motorist on Belle Isle in the middle of the Detroit River. He gallantly offered to crank the car for the stranded driver. When she forgot to retard the spark, the crank kicked and broke Carter’s jaw. Complications developed, and Carter later died of pneumonia. When Cadillac chief, Henry M. Leland, heard the news, he was distraught. Byron Carter was a friend and the car that kicked back was a Cadillac. “The Cadillac car will kill no more men if we can help it,” he told his staff.

He called Charles Kettering. The engineers at Delco worked around the clock to solve the problem. Leland approved their revolutionary electric starter and generator for his 1912 model and placed an order for 12,000 units. The same basic technology is still used today in modern automobiles.

Good ideas can come from any number of places. The end-user of a technology is invaluable when it comes to what does or doesn’t work. Sales and marketing types in the field are classic sources for this “voice of the customer” feedback. Knowledgeable engineers are equally valuable sources of good ideas—especially when it comes to clever ways to solve a problem. Often, a good idea can come from someone outside a system or industry, as folks “inside a bubble” can tend to be influenced by ingrained taboos and traditions.

I have noticed here at Glenair that many of our best ideas originate with team members who are just plain not afraid to suggest a new way to tackle an old problem—regardless of what role they play in the organization. I absolutely cherish this behavior (what some folks call “acting like an owner”). Linus Pauling said “the best way to have a good idea is to have lots of ideas.” That sounds about right to me.

Chris Toomey