Space-Grade Interconnect Solutions

Proven, Rugged, Flight-Heritage Technologies
Glenair: Supplying Mission-Critical Interconnect Solutions since 1956

Markets served:

- Military / commercial aerospace
- Outer space
- Underwater / subsea / navy
- Transportation / rail
- Soldier / land warfare
Space-Grade Design Disciplines: Reliability

Deep fluency in the real-world mechanical challenges of designing for space

- Launch shock and vibration
- Temperature extremes
- Dynamic and installation flex
- Blind separation
Space-Grade Design Disciplines: *Performance*

Deep fluency in optimizing package design for advanced performance

- Reduce payload weights
- Reduce interconnect package size/increase contact density
- Reduce wear and tear mating-cycles on deliverable connectors
- Assure reliable satellite deployment/interconnect separation
Space-Grade Design Disciplines: *Survival*

Deep fluency in the extremes of space that degrade performance

- Eliminate condensable material outgassing
- Assure barrier/interconnect sealing and hermeticity
- Manage EMI/RFI and high-dose-rate space radiation
- Survive temperature extremes
- Prevent atomic oxygen corrosion
Glenair Worldwide Space-Grade Manufacturing and Assembly Capabilities

- Three space-grade manufacturing and assembly factories with clean rooms: Glendale, CA; Mansfield UK; Glenair Space Systems (Salem, Germany)
- Certified independent test laboratories (ISO/IEC 17025:2005, IECQ 01 and IECQ 03-6)
- NASA, ESA and JAXA outgassing and screening processing
- Nadcap and ESA special processes and PCB assembly
- In-House space-grade Class G Plating
- Flight legacy on hundreds of programs
Special Testing of Non-Metallic Materials for Use in Space Grade Applications

- Volatile materials testing for nonmetallic materials under ASTM E 595
- Space hardware materials selection IAW MSFC-HDBK-527
- 8 hour 400° bakeout process
- 24 hour 125° thermal vacuum outgassing process
Special Qualification of Metallic Materials for Control of Stress Corrosion Cracking

Per MIL-STD-3029 Rev A

- Dynamic and static stress tests in NaCl (salt fog) over proscribed timeframes to control for potential premature material failure (cracking)
### Space-Grade Connector Screening

Per NASA screening levels and IAW MSFC-SPEC-548 for vacuum outgassing of electrical connectors for space payloads

<table>
<thead>
<tr>
<th>Screening Level</th>
<th>Special Screening Only</th>
<th>Special Screening Plus Outgassing Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Interfacial Seal is Installed</td>
<td>Interfacial Seal is Omitted</td>
</tr>
<tr>
<td>ESA Level 1 Highest Reliability</td>
<td>Mod Code 897E</td>
<td>Mod Code 897F</td>
</tr>
<tr>
<td>ESA Level 2 High Reliability</td>
<td>Mod Code 897B</td>
<td>Mod Code 897D</td>
</tr>
<tr>
<td>ESA Level 3 Standard Reliability</td>
<td>Mod Code 897</td>
<td>Mod Code 897L</td>
</tr>
<tr>
<td>NASA Level 1 Highest Reliability</td>
<td>Mod Code 429B</td>
<td>Mod Code 429F</td>
</tr>
<tr>
<td>NASA Level 2 High Reliability</td>
<td>Mod Code 429</td>
<td>Mod Code 429D</td>
</tr>
<tr>
<td>NASA Level 3 Standard Reliability</td>
<td>(Use standard part number)</td>
<td>Mod Code 432</td>
</tr>
</tbody>
</table>
Special Process Certifications

IAW SAE Aerospace Standard AS7003 for Electronics and ESA Certification requirements for assembly technicians

- Certified Nadcap module assembly and test of PCBA integrated circuits, resistors, capacitors, transceivers, and other components.
- Nadcap flat flex operation certified
- Soldering and crimping process in accordance with ECSS-Q-ST-70-08, ECSS-Q-ST-70-26 and IPC-J-STD-001
- ESA Certification (GSS and UK)
Space-Grade Complex Cable Assemblies: USA

Heritage dating from Commander Ed White’s first spacewalk

- Molded (Viton) assemblies
- Turnkey conduit assemblies
- Shielded harnesses
- Integrated Flex assemblies

- JPL Mars Probes
- AIRS Satellite
- Gravity Probe Satellite
- Space Shuttle
- Titan Launch Vehicle
Space-Grade Micro and Nano Wire and Flex Assemblies: UK

- 30 years experience plus IPC and ESA Certification
- Radar, EO sensors, missiles, satellite and space applications
  - Herschel Space Observatory
  - James Webb Space Telescope
  - GAIA optical astronomy satellite
  - Skynet 5 Military Satellite
  - ALMA Space Telescope
  - JPL Mars Probe and Mars Curiosity Rover
  - AIRS Satellite
  - Kinetic Kill Vehicle (KKV)
  - Cassini
  - CrIS and Northrop Space NPOESS Satellite
Flight-Grade Harness Assemblies: GSS (Salem)

Certified Harnesses Fabrication and Turnkey system integration

Reference applications: ACLS and Lisa Pathfinder
Satellite Test Capabilities: GSS (Salem)

EGSE rack systems and interface / simulation programming

- IDAS test racks for Exomars, EML, EarthCare, BepiColumbo, Sentinel 1, Sentinel 2, Sentinel 6 Jason, and others
Satellite Test Capabilities: GSS (Salem)

Turnkey fabrication and integration of test harnesses for engineering models and satellites
Non-Explosive Space Mechanisms

HDRMs • Pin Pullers • Pin Pushers

- Pyrotechnic-free
- User-serviceable and refurbishable
- Extended temperature range -150°C to +150°C
- EMI/EMP/RFI/ESD shielded
- Scalable: Light, medium, and heavy-duty solutions
Scalable Design

- Fuse-wire based technology
- Electrical initiation as low as 1.5 Amps with no maximum current limit
- Scalable designs: from Nano-Satellite versions to rated 20,000 pound units
HD Stacker Board-to-Board Connectors

The high-density, rugged board-to-board stacking connector

- Parallel board stacking connector
  - Board-to-board
  - Board-to-cable/flex
- PCIe 3.0 capable
- Solder free “eye of the needle” compliant tail for press fit installation
- Replaceable BeCu contacts
- High-density .0625” pitch Chevron Contact System
HD Stacker Key Features

The high-density, rugged board-to-board stacking connector

- Performance up to 10.5 Gbps
- Polarized insulator and hardware options
- High-temp PPS insulator meets NASA outgassing requirements
- Available wired / flex jumpers
- Available between-board spacers up to 1 inch
Latch MicroStrip™

TwistPin contact performance, optimal size and weight

- High-reliability TwistPin contact system
- #24-30 AWG wire size
- .050" pitch contact spacing
- Solder cup, pre-wired or PCB header terminations
- 3 Amps, +150C, 600 Vac
Latchings MicroStrips™

Packaging

- Socket and pin strips with guide pins for wire-to-wire applications
- Right-angle PCB headers with end latches
- Right-angle PCB headers with staggered PC tails and center latch
- Back-to-back jumpers
Space-Grade Fiber Optic Interconnect Solutions

- MIL-DTL-38999 Series III Type
- MT Ferrule with D38999 packaging
- GHD Glenair High Density
- Series 80 Mighty Mouse
Overview of Glenair Photonics / Opto-Electronics

Inside the box: Ruggedized transceivers and parallel optical transceivers

At the box interface: Photonic contacts and connectors

Outside the box: Fiber-to-copper media converters
Micro and Nano Interconnects Produced IAW NASA, ESA and JAXA Requirements

MIL-DTL-83513 QPL (ESCC3401-029) board-mount, panel mount and free-cable connectors
Environmental, hermetic, filter, Sav-Con (ESCC3401-041) and flex assemblies with outgassing processing

- Herschel Space Observatory
- James Webb Space Telescope
- GAIA optical astronomy satellite
- Skynet 5 Military Satellite
- ALMA Space Telescope
- JPL Mars Probe, Mars Curiosity Rover, InSight Mars Lander
- AIRS Satellite
- Kinetic Kill Vehicle (KKV)
- Cassini
- CrIS and Northrop Space NPOESS Satellite
Glenair Innovation: Micro-D Right Angle (GMDR)

Pigtail Micro-D with right-angle wire exit – saves space!
Glenair Innovation: GMSM Low Profile
Single Row

- Low profile Micro-D in a single row format
- Ideal for when signal pairs need to be kept separate
- Flying lead, solder bucket and PCB mount options available
- Contact arrangements: 4 to 35 ways
- Backshells available
The SpaceWire protocol has been used on over 100 flight programs.

Glenair offers lab and flight cables IAW ESA/ ECSS-E-ST-50 standard

Uses qualified MIL-DTL-83513 Micro-D connectors

100-Ohm impedance shielded twisted pair cable

Suitable for Ethernet protocol, radar sensor applications, high-resolution camera equipment, and telemetry
Series 89

Nano Connector Features

- Contact spacing 0.025 inches (0.635 mm) housed within a metal body
- Available space-grade materials:
  - Plated aluminium (Electroless Nickel)
  - Stainless Steel
  - Titanium
- Single or Dual row layouts
- Contact arrangement 9 to 51 way and 65, 69, 85
- Qualified MIL-DTL-32139 and commercial versions
DSCC Space Qualified Series 89 Class S Nanominiature Connectors

Available with outgas processing IAW NASA EEE-INST-002

MIL-DTL-39129 QPL (ESCC3401-086) board-mount, panel mount and free-cable connectors

Environmental, filter and flex assemblies

- Herschel Space Observatory
- James Webb Space Telescope
- LSST Space Telescope
- ESA/ESTEC qualification in progress
HiPer-D High-Performance M24308

Materials and construction

- Precision machined aluminum shell
- Thermoset epoxy insulators
- Sealing at front and rear
- Electroless Nickel plated EMI spring fingers
Series 28 HiPer-D High Performance
M24308 Intermateable D-Sub

Qualified MIL-DTL-24308 Class K Space-Grade Hermetic

Series 28 HiPer-D environmental, hermetic, filter, Sav-Con and cordsets

- Ball Aerospace
- LMCO Denver
- Orbital Sciences
Ultraminiature Series 80 Mighty Mouse Connectors

Package size, ultra light weight and contact density are ideally for Space Grade programs

Series 80 Mighty Mouse environmental, hermetic, filter, Sav-Con and cordsets

- Mars Exploration Rovers
- Mars Science Laboratory
Series 806 Mighty Mouse Mil-Aero

Next-generation high-density connector for demanding aerospace and defense applications

- Signal/sensor interconnect for both pressurized and non-pressurized airframe applications or suitable applications
- Meets 38999HD performance benchmarks (altitude immersion, vibration and shock, mating durability, temperature and voltage)
- Class G Space-Grade
Mighty Mouse 806 Mil-Aero vs. D38999
Size Comparison

D38999 Size 9
3 #20 Contacts
6 #22 Contacts
9 #23 Contacts
.858" Diameter

Sr. 806 Size 11
10 #20 Contacts
19 #22 Contacts
.890" Diameter
High Density Series 79
Micro-Crimp Connector

No-solder Crimp Contact System

A proven product, exclusively from Glenair
Ideal for guide pin and rack-and-panel applications

- Low-Earth-Orbit and Geosynchronous-Earth-Orbit satellites
- Orion Spacecraft
- Ball Aerospace
- Honeywell Space
- LMCO Denver
- NuStar / NASA JPL

Guide-pin and guide-socket equipped mountable connector halves for rack-and-panel misalignment accommodation

Chamfered plug and receptacle shell mating interface (note profile of interfacial seal)

Integrated EMI grounding and shielding element
Series 791 Ultraminiature Rectangular

Ultraminiature (.076 contact spacing) and Innovative:

- Crimp contact termination
- Dual-lobe shell
- Recessed scoop-proof pins
- Large-format mounting hardware
- Integral ground spring
- Panel O-ring seals
- Integral band platform
- Available keying
Connector Savers

Available for every currently specified circular and rectangular connector series

- Boeing Satellite Systems
- Delta 4 Launch Vehicle
- NASA Space Shuttle
- Voyager, Galileo, Magellan, Cassini, Pathfinder, Curiosity, Orion
SuperNine Class G Space

- MIL-DTL-38999 QPL Connector Styles
  - D38999/20 (wall-mount receptacle)
  - D38999/24 (jam nut receptacle)
  - D38999/26 (plug)

- QPL Plating classes
  - F (electroless nickel, 48 hr. salt spray)
  - G (space-grade electroless nickel, 48 hr. salt spray, RoHS compliant)
  - W (cad/O.D. over electroless nickel, 500 hr. salt spray, non-RoHS compliant)
  - T (Nickel-PTFE, 500 hr. salt spray, RoHS compliant)
SuperNine Circular Blind Mate, Rack-and-Panel and Assisted Separation Series

Roll-off nose
Misalignment accommodation
Environmental sealing
EMI shielding
Kick-off capability (assisted separation force)
SAE-AS81703 Series 3 Type

IAW NASA, ESA and JAXA standards

- Designed for rugged vibration and shock, including space-grade applications such as space telescope deployment and rack-and-panel research equipment
- Signal and power insert arrangements
- High-speed shielded Coax, Twinax and Quadrax
EMI/RFI Filter Connectors

Compliant to EEE-INST-002, Table 2G

- MIL-DTL-38999 type, Series 80 Mighty Mouse, and other circulars
- Series 28 HiPer-D and Series 79 Micro-Crimp filtered rectangulars

<table>
<thead>
<tr>
<th>Company</th>
<th>Supplier</th>
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<tbody>
<tr>
<td>Ball Aerospace</td>
<td>Nasa / JPL</td>
</tr>
<tr>
<td>Boeing</td>
<td>Northrop Grumman</td>
</tr>
<tr>
<td>General Dynamics</td>
<td>Orbital Science</td>
</tr>
<tr>
<td>Honeywell</td>
<td>Sierra Nevada Corp</td>
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<tr>
<td>Lockheed Martin</td>
<td>SpaceX</td>
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<tr>
<td>MIT Lincoln Labs</td>
<td>Tesat</td>
</tr>
</tbody>
</table>
Standard Filter Packaging for Space: Circulars

Series 80 Mighty Mouse
Series 970 PowerTrip™
MIL-DTL-38999 Series III type
Standard Filter Packaging: for Space: Rectangulars

MIL-DTL-83513

Series 79 Micro-Crimp

M24308 and HiPer-D
Hermetic Receptacles and Bulkhead Feed-thru Connectors

High-pressure/low-leakage space applications

MIL-DTL-38999 Series I, II, III and IV QPL and Series 80 Mighty Mouse hermetic circulars
Series 79 Micro-Crimp and Series 28 HiPer-D hermetic rectangulars

- X-38 Jettison Escape Pod (International Space Station)
- Qualified SSQ21635 Class Y Bulkhead Feedthrus (ISS)
- Pegasus
- Boeing Satellite Systems
- MetOp satellite
- SpaceX Launch Vehicles and Spacecraft
The Lightweight Hermetic Challenge

Full hermetic sealing (10^{-7}) in a lightweight connector shell package, with low contact resistance AND mission-critical durability

- Glass-to-metal seal furnace temperatures are too high for lightweight aluminum and low-resistance copper contacts
- Conventional epoxy potting lacks sealing strength and mission-critical durability
Lightweight CODE RED Hermetics

- Hermetic Seal = $1 \times 10^{-7}$
- Light weight, corrosion resistant materials
- Low-resistance copper alloy contacts
- Extreme temperature tolerance
- Meets NASA outgassing
- Turnkey, drop-in replacement for glass-seal hermetics
- Can be used in various product families and shell geometries
Circular Backshells and Accessories

Qualified to SSQ 21635, 21636 and 22698

EMI shield termination, cable strain relief, connector protective covers and more
Lightweight composite versions

- International Space Station
- Northrop Grumman Space Technologies
- Loral Space Systems
- Boeing Satellite Systems
- Ariane Launch Vehicle
- SEA Launch
- Space Shuttle
- Titan Vehicle
Space-Grade Rectangular Backshells

Qualified to SSQ 22681

EMI shielding and strain relief backshells for D-Sub micro and nano connectors (ESCC3401)
Lightweight composite versions

- Gravity Probe
- International Space Station
- MetOps
- Space Infrared Telescope
- Northrop Grumman Space Technologies
- Boeing Satellite Systems
- Herschel Space Observatory
- GAIA satellite
- Skynet 5 Military Satellite
- James Webb Telescope
Nickel-plated microfilament composite shielding offers lightest weight solution to electromagnetic compatibility

- Electrically conductive plated composite
- Superior high-frequency shielding in high temperature applications
- Comparable shielding performance to 36 AWG plated tubular copper braid
- Lightweight, corrosion-free
- Weight savings up to 88% per foot compared to standard nickel-copper braid
Ultra-Lightweight AmberStrand®
Composite Plastic EMI Braid

Microfilament metal-clad composite EMI/RFI cable braid and ground straps

- EADS Astrium
- Honeywell Space
- SpaceX
- Cassini Program
- Orbital Sciences Space Probes
- Space Crest Program
- Lockheed-Martin Missiles and Space Systems
- JPL Mars Pathfinder
- CrIS Satellite
Microfilament EMI/RFI Shielding

70+% lighter than standard metal EMI/RFI braid

- Expandable, flexible, high-strength, lightweight, conductive, microfilament material
- Provides abrasion resistance and EMI shielding at a fraction of the weight of standard metallic braid
- Maintains metallic core conductivity in event of plating damage during assembly or maintenance
Microfilament Braided Shielding

Innovative expandable, high-strength conductive stainless-steel braid

- Orbital Sciences - BMD / MDA GMD Programs
- Ball Aerospace - OMPS, Aquila, JPSS
MasterWrap™ with ArmorLite Technology

Ultra-flexible, side-entry EMI/RFI shielding

- **Saves weight:** 70% material weight reduction compared QQ-B-575 / A-A-59569 nickel copper
- **Simplifies Installation:** Replaces harder-to-install tubular EMI/RFI sleeving
- **Saves Time:** Fast and easy side-entry installation and removal
- **Improves EMI/RFI shielding:** Reduces windowing and coverage gaps
- **Improves Performance:** Delivers superior flexibility, durability and reparability
Glenair is the High-Reliability, High-Quality Standard

- Depth of qualifications and approvals from 60 years in the business
- Deep fluency in materials, design, test and fabrication
- Proven interconnect solutions that solve major performance problems
- “On the print” of thousands of bench-mark programs
Space-Grade Interconnect Solutions

Proven, Rugged, Flight-Heritage Technologies