Space-Grade Interconnect Solutions
Reliability • Availability • Performance

The widest range of mission-critical interconnect technologies in the world
Interconnect Package Design for Reliability

Addressing the real-world mechanical challenges of designing for space

- Launch shock and vibration
- Temperature extremes
- Dynamic and installation flex
- Blind separation
Interconnect Package Design and Performance for Space

Interconnect design and engineering disciplines which:

- 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
Interconnect *Environmental* Design and Performance for Space

Interconnect design and engineering disciplines which:

- 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
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>
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<tbody>
<tr>
<td></td>
<td>Interfacial Seal is Installed</td>
<td>Interfacial Seal is Omitted</td>
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<tr>
<td>ESA Level 1</td>
<td>Mod Code 897E</td>
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<tr>
<td>Highest Reliability</td>
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<td>Mod Code 897D</td>
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<tr>
<td>High Reliability</td>
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<tr>
<td>ESA Level 3</td>
<td>Mod Code 897</td>
<td>Mod Code 897L</td>
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<tr>
<td>Standard Reliability</td>
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<tr>
<td>NASA Level 1</td>
<td>Mod Code 429B</td>
<td>Mod Code 429F</td>
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<tr>
<td>Highest Reliability</td>
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<tr>
<td>NASA Level 2</td>
<td>Mod Code 429</td>
<td>Mod Code 429D</td>
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<tr>
<td>High Reliability</td>
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<td>Mod Code 432</td>
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<tr>
<td>Standard Reliability</td>
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Special Process Certifications

IAW SAE Aerospace Standard AS7003 for Electronics

- 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
Space-Grade Complex Cable Assemblies

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
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
HDRM, Pin Puller/Pusher Offerings

Key variables overview

- Pounds of release preload
- Hold down and release vs. pin pullers and pushers
- Redundant circuit and non-redundant circuit
- Hard-wired vs. connectorized
Scalable Mechanisms

- 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
HDRM Preload

No physical gap is GOOD

A gap will cause the structures to hit each other repeatedly which is catastrophic

The force applied to the gap is called PRELOAD

Higher preload means the HDRM is expected to resist more forces to prevent gapping

If external forces exceed the preload, a gap may occur, potentially resulting in damage
What are Pin Pullers and Pushers?

- Pin pullers and pushers are simple single-action devices.
- They retract a pin rearward, or push it forward (as shown).
- Used in many applications in space or on earth:
  - Fire suppression systems
  - Door releases
  - Satellite openings
Refurbishment for HDRM or Pin Puller

Key design strength

- Standard tools to refurbish
- 10 – 15 minutes to refurbish unit once it is off the structure
- Initiator is a consumable assembly
- Glenair can train directly and send proper refurbishment documentation
- Factory refurbishment for flight hardware available
- Post installation verification test: electrical, proof load etc.
HDRMs with Proven Flight Heritage

Space mechanisms with TRL ratings of 9

061-005 Medium-Duty HDRM
Redundant circuit, 2500 lb. release preload
Two successful space deployments
TRL of 9

061-007 Medium-Duty HDRM
Redundant circuit, 300 lb. release preload
At least one successful flight deployment
TRL of 9
Qualification Test Standards

- **Pin Pullers**
  - Holding and releasing a 40 lbs. preload
  - Holding side load greater than 300 pounds
  - Random Vibration of 28.2 Grms
  - Shock Input of 2849 G’s
  - Three (3) cycles of Thermal Vacuum from +70 °C to -65 °C at vacuum pressure of 1 x 10-6 torr minimum

- **Bolt/Screw HDRMs:**
  - Sine Vibration @25 G’s
  - Random Vibration @50.9 G’s Overall
  - Environmental Shock Input of 2849 G peak
  - Thermal Vacuum @ ±150°C, 10 cycles with actuations
  - Shock Output <300 G’s @ 2500 lbs.
HD Stacker Key Features

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™

**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
Latching 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
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
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
  - Ball Aerospace
  - NASA / JPL
  - Boeing
  - Northrop Grumman
  - General Dynamics
  - Orbital Science
  - Honeywell
  - Sierra Nevada Corp
  - Lockheed Martin
  - MIT Lincoln Labs
  - Tesat
Standard Filter Packaging: Circulars

- Series 80 Mighty Mouse
- Series 970 PowerTrip™
- MIL-DTL-5015 type
- MIL-DTL-38999 Series I type
- MIL-DTL-38999 Series III type
Standard Filter Packaging: Rectangulars

MIL-DTL-83513

Series 79 Micro-Crimp

M24308 and HiPer-D

ARINC 400 and 600
Filter Connector Sav-Con®
Connector Savers
For pain-free resolution of EMI in deployed electronics

Micro-D
D-sub
D38999 Series III
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 and Mars Curiosity Rover
- AIRS Satellite
- Kinetic Kill Vehicle (KKV)
- Cassini
- CrIS and Northrop Space NPOESS Satellite
MIL-DTL-83513 Qualified Micro-D Subminiature Connectors

- Glenair is fully accredited to all released MIL-DTL-83513 approvals.
- Large Same-Day Stock of Mil 83513 and COTS product
- All of our Mil 83513 product are built using the TwistPin contact system
Glenair Micro-D Right Angle (GMDR)

Pigtail Micro-D with right-angle wire exit – saves space!
Rear Panel Mount Micro-D (GRPM)

Connector configurations

- All standard Micro-D’s
  - Solder cup
  - Pigtail
  - Circuit board
- O-Ring: C = conductive; N = non-conductive (Nitrile)
- Hardware: Rear panel mount jackpost with panel thickness .032-.125
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
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
Product Family

- Plugs
  806-012

- Square Flange Receptacles
  806-013

- Line Receptacles
  806-019

- Jam Nut Receptacles
  806-020

- Jam Nut PCB Receptacles
  806-021

- Square Flange PCB Receptacles
  806-022

- Hermetic Receptacles
  806-025

- Hermetic PCB Receptacles
  806-026

- Filtered Receptacles
  240-806

- Filtered PCB Receptacles
  240-806-21
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)
- Replaces legacy large form-factor connector series (38999, 5015, 26482)
Key Performance Benchmarks
IAW D38999

- DWV at altitude
- Indirect lightning strike
- Altitude immersion
- Vibration and shock
- Shielding effectiveness
- Class G space grade
Mighty Mouse 806 Mil-Aero Advantages

Compared to other microminiature circular connectors

- Higher Temperature
- Higher Vibration
- Improved Moisture Resistance
- Higher Voltage
- Lightning Strike
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 Ultramiiniature Rectangular

Ultramiiniature (.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
Series 791 Ultramiiniature Rectangular

Application Examples

- Board-mount differential Twinax
- Board-mount ultra high-density hybrid VersaLink
- Board-mount octaxial Ethernet / USB / high-speed datalink
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
A blind mate connector is any interconnect that can be coupled without the need to “see” the connection during mating.

Rack-and-Panel method allows for mating using racks and panels with guide pins.

Typically a push-pull mate that does not require a coupling nut.

When necessary, designs may incorporate an assisted separation force spring.
Glenair Circular Blind Mate, Rack-and-Panel Connector Key Features

- 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
AS81703 Series 3 Type

- Intermateable and intermountable with available AS81703 connectors
- Reliable fail-safe axial-pull lanyard equipped coupling
- Instant disconnect for critical quick-release systems
- Polarization keying for mis-mate prevention
Lanyard-Release Quick-Disconnect Connectors

For disengagement and release of launch and payload

- Jam-free push-on, pull-off operation
- Reliable fail-safe axial-pull lanyard equipped coupling
- Instant disconnect for critical quick release systems
- Blind mate and rack-and-panel versions available
- Qualified for military and space applications
Hermetic Sealing Can Be Implemented for Any Circular Connector Package...

Technology supports both pin and socket contact in any receptacle style

MIL-DTL-26482  MIL-DTL-83723  MIL-DTL-38999  MIL-DTL-5015  Series 80 Mighty Mouse

These are all standard catalog product offerings at Glenair
And For All Rectangular Designs

MIL-DTL-24308

MIL-DTL-83513

Again, standard catalog product offerings at Glenair
Special Hermetic Quadrax Connectors

-50°C to +200°C, 1x10^-9 cc/sec rated
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
CODE RED Features and Benefits

- Hermetic Seal > 1X10^-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
Glenair Space-Grade Manufacturing and Assembly Capabilities

- Space-grade clean room for interconnect assembly
- Certified independent test laboratories (ISO/IEC 17025:2005, IECQ 01 and IECQ 03-6)
- NASA, ESA and JAXA outgassing and screening processing
- Nadcap special processes and PCB assembly
Space-Grade Interconnect Solutions
Reliability • Availability • Performance