QwikConnect

GLENAIR • JANUARY 2021 • VOLUME 25 • NUMBER 1

INTERCONNECT TECHNOLOGY *for* Manned Space Flight

Glenair® SPACE SYSTEMS

Behind-the-scenes at Glenair GSS, Salem GER

PLUS an in-depth look at space radiation

Glenair: The Most Trusted Name in Manned Space Connectors and Cables

Commander Ed White's "Golden Umbilical" cable—and the numerous Titan II / Gemini launch cables manufactured by Glenair's cable division in Southern California—were essential to America's early manned space program.

Glenair's history of interconnect innovation for manned space applications began with our design and fabrication role in the realization of the golden umbilical life-support cable used by Commander Ed White in the first American Gemini Program space walk in 1965. This was a complex cable assembly with an exacting set of performance requirements. Even though this application is now over 50 years old, it still reflects Glenair's unique skill set as both a manufacturer of high-performance connectors and wire protection products as well as a provider of turnkey assemblies incorporating Glenair signature interconnect technology. Complex interconnect cable assemblies made by Glenair have traveled to and from orbit dozens of times on the Space Shuttle, and we were also responsible for producing the long-length umbilical cables used on the Titan II launch vehicle for all twelve Gemini missions. For this application, Glenair developed some truly unique fabrication fixtures and processes to complete this unique cable build.

< Gemini VIII launch, Titan II launch vehicle with umbilical cables in view on launch tower.

PAST HISTORY OF PERFORMANCE IN MANNED SPACE APPLICATIONS

- The "Golden Umbilical" life-support cable
- Titan II space launch vehicles
- Space Shuttle orbiter
- International Space Station
- X-38 experimental spacecraft

50+ Years of Crewed-Flight Interconnect Design History

The X-38
Crew Return Vehicle

A Select History of Glenair Connectors and Backshells in Manned Space Flight Applications

Glenair discrete interconnect designs and technologies have been a part of manned space flight for these past 50+ years. And, as mentioned, we have demonstrated capability in-house to integrate our many unique and signature interconnect technologies into turnkey systems and assemblies. In each of the following examples, Glenair performed exactly in this manner, acting not merely as a supplier, but as an application engineering and design partner to these landmark programs.

Glass-Sealed Hermetics for the X-38 Crew Return Vehicle

Glenair supplied specialized glass-sealed hermetic connectors to The X-38 program, an experimental autonomous spacecraft designed and built for the purposes of shuttling space crew back to Earth in an orbital emergency. Glenair has been an essential go-to supplier and design partner for hermetically-sealed connectors on space flight programs since the 1980s.

‹ Hermetic sealing available in circular and rectangular packages

QwikClamp® Backshells for the International Space Station

The Glenair QwikClamp® backshell was purpose-designed for use on the ISS. Select parts were gold plated for resistance to atomic oxygen corrosion and radiation damage, others were supplied in our "M" code electroless nickel plating. All designs were equipped with a unique strain relief clamp that eliminated sharp surfaces and angles to prevent potential damage to astronaut life support space suits and gloves. Here is astronaut Thomas D. Jones in 2001 during STS-98 out on an EVA. The cable assemblies in the shot are all equipped with these unique Glenair backshells.

‹ Astronaut Thomas D. Jones, mission specialist, works on the International Space Station during STS-98 in this 2001 file photo.

Space-grade Qwik-Clamp backshells designed for the International Space Station

Glenair Sav-Con®
Connector Savers

Sav-Con® Connector Savers for the Space Shuttle orbiter

Glenair Sav-Con® connector savers have been on every major manned space program—from Gemini to the Space Shuttle. One of the most dramatic applications of this space-grade connector go-between was on the Space Shuttle orbiter where they provided protection for the umbilical connectors from liftoff to touchdown on every mission.

Launch of a Space Shuttle orbiter Vehicle from the Kennedy Space Center

Photo History of Manned Space Flight

Source: NASA

Mercury

A camera aboard the “Friendship 7” Mercury spacecraft photographed Astronaut John H. Glenn Jr. on Feb. 26, 1962, during the Mercury-Atlas 6 spaceflight. Glenn was using a photometer to view the setting sun.

Gemini

On June 3, 1965 Edward H. White II became the first American to step outside his spacecraft and let go, effectively setting himself adrift in the zero gravity of space. For 23 minutes White floated and maneuvered himself around the Gemini spacecraft. White was attached to the spacecraft by a 25 foot umbilical line and a 23-ft. tether line, both wrapped in gold tape to form one cord. In his right hand White carries a Hand Held Self Maneuvering Unit (HHSMU) which is used to move about the weightless environment of space. The visor of his helmet is gold-plated to protect him from the unfiltered rays of the sun.

Apollo

Astronaut Buzz Aldrin walks on the surface of the moon near the leg of the lunar module Eagle during the Apollo 11 mission. Mission commander Neil Armstrong took this photograph with a 70mm lunar surface camera. While astronauts Armstrong and Aldrin explored the Sea of Tranquility region of the moon, astronaut Michael Collins remained with the command and service modules in lunar orbit.

Skylab

Scientist-astronaut Owen K. Garriott, Skylab 3 science pilot, is seen performing an extravehicular activity at the Apollo Telescope Mount (ATM) of the Skylab space station cluster in Earth orbit. Garriott had just deployed the Skylab Particle Collection S149 Experiment from its mount on one of the ATM solar panels. The purpose of the experiment was to collect material from interplanetary dust particles on prepared surfaces to study their impact phenomena. Earlier during the EVA Garriott assisted astronaut Jack R. Lousma, Skylab 3 pilot, in deploying the twin pole solar shield.

Space Shuttle

The crew of STS-61A poses for their traditional in-flight portrait. Eight ESA and NASA astronauts (the current record) flew the Space Shuttle Challenger, carrying the NASA/ESA Spacelab module into orbit with 76 scientific experiments on board. The Space Shuttle Orbiter carried crews to and from Low Earth Orbit on 133 successful missions between 1981 and 2011.

International Space Station

ESA astronaut Leopold Eyharts (left), flight engineer, along with NASA astronauts Leland Melvin and Daniel Tani, mission specialists, are pictured here working in the Destiny laboratory of the International Space Station. For over 22 years, astronauts, cosmonauts, and space tourists from 19 different nations have visited the space station, conducting research in astrobiology, astronomy, meteorology, and physics, and testing the spacecraft systems and equipment required for future long-duration missions to the Moon and Mars.

SpaceX Crew-1

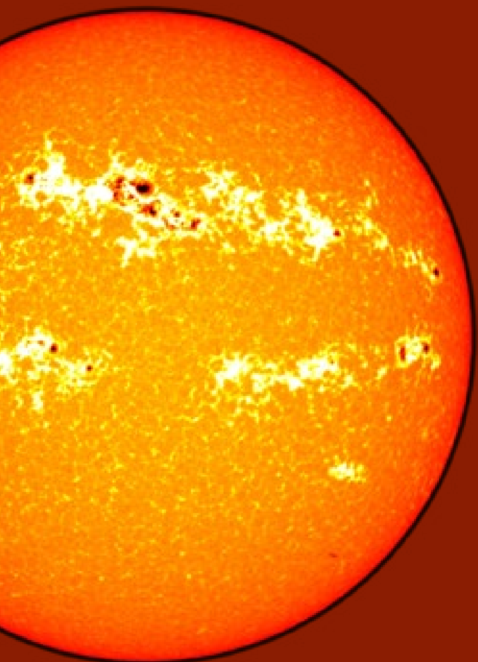
From left, Mission Specialist Shannon Walker, Pilot Victor Glover, Crew Dragon Commander Michael Hopkins—all NASA astronauts—and Japan Aerospace Exploration Agency (JAXA) astronaut and Mission Specialist Soichi Noguchi are seated in SpaceX's Crew Dragon spacecraft during crew equipment interface training. The NASA SpaceX Crew-1 mission lifted off from Kennedy Space Center on November 15, 2021, and successfully docked at the International Space Station on November 17 where they begin a six-month stay.

Orion

Spacesuit engineers demonstrate how four crew members would be arranged for launch inside the Orion spacecraft, using a mockup of the vehicle at Johnson Space Center. Orion (officially Orion Multi-Purpose Crew Vehicle or Orion MPCV) is a class of partially reusable space capsules to be used in NASA's human spaceflight programs.

TECH BRIEF

Impacts of Space Radiation on Interconnect Wire Harnessing

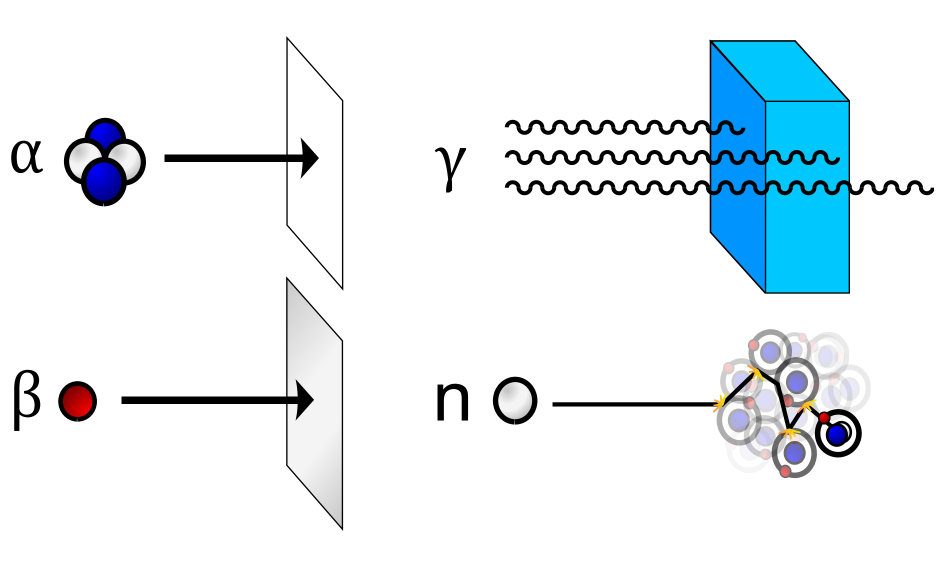


The sun is a major source of electromagnetic radiation impacting satellites in low earth orbit. Direct impacts from solar flares and solar wind dominate the radiation environment experienced by LEO satellites.

Low Earth Orbits are increasingly being utilized by satellite networks geared for principal delivery of internet content on a worldwide basis. Low Earth Orbit, or LEO, happens to be relatively free from charged solar particles as it sits below the inner and outer Van Allen belts. Ionizing radiation remains an important factor however, and polar LEO orbits do cross charged particle areas at every pass. One of the questions we get asked quite frequently at Glenair is whether or not a particular interconnect technology is resistant to space radiation. The answer to this question of course depends on the particulars and specifications of each individual application, as the physics of radiation in space—for example as it pertains to satellites in low earth orbit versus those subject to radiation effects in deep interplanetary space—are significantly different.

In general, radiation that hits a spacecraft comes from either of two sources. The first is the sun, and if we understand its direct and indirect effects we will have mastered 99% of the subject at hand. However there is a small percentage of space missions that cannot rely solely on the sun as its source of energy. Such satellites often carry a small nuclear reactor called a radioisotope thermoelectric generator (RTG) which converts heat from a nuclear decay process into electricity. Generators of this type do emit some radiation, but that's not the focus of the vast majority of the applications we see, which are almost exclusively focused on solar radiation.

RADIATION TYPES



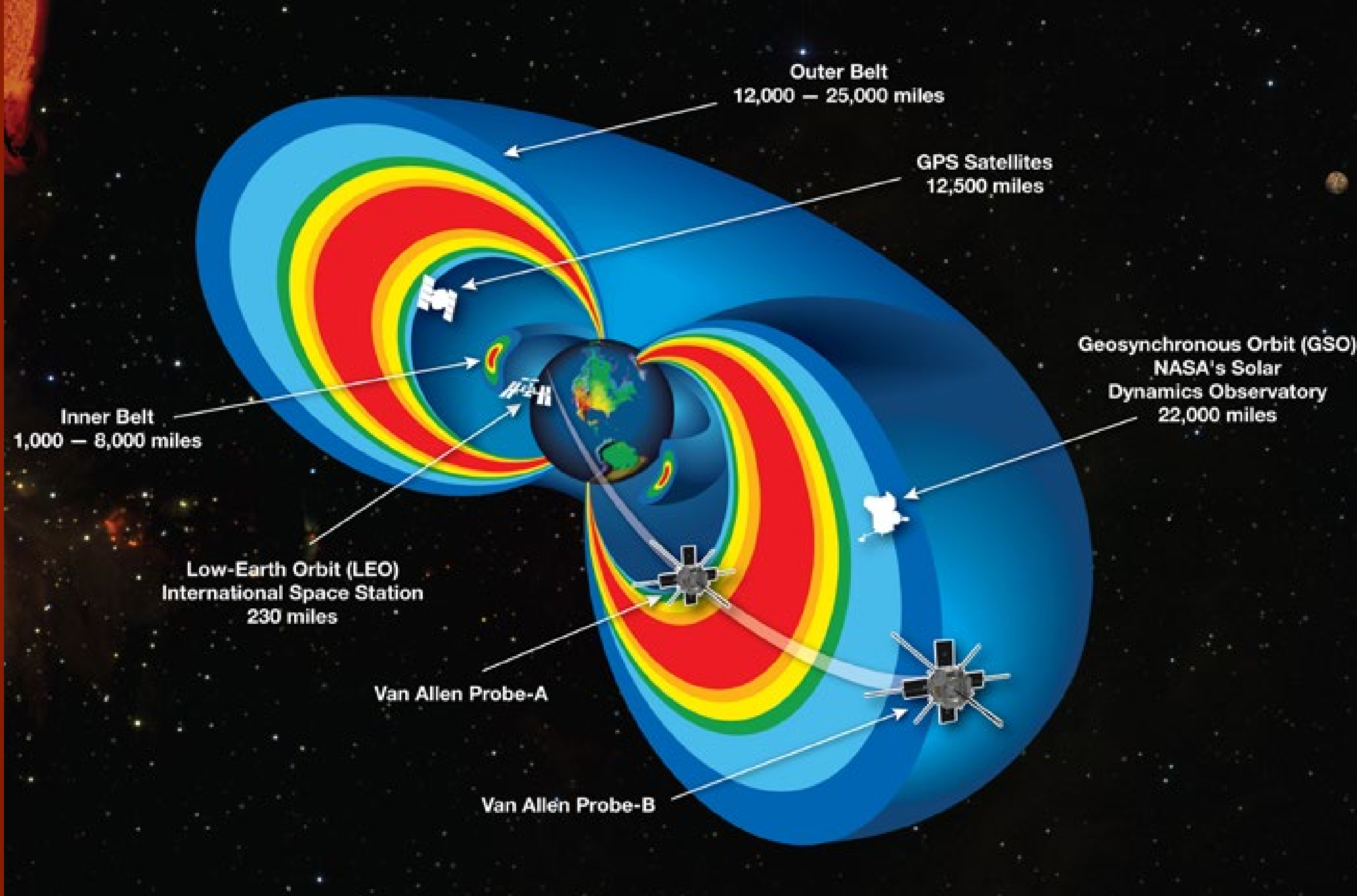
Alpha (α) radiation consists of a fast-moving helium-4 nucleus, and is stopped by a sheet of paper.

Beta (β) radiation, consisting of electrons, is halted by an aluminum plate.

Gamma (γ) radiation, consisting of energetic photons, is gradually absorbed as it penetrates dense material.

Neutron (n) radiation consists of free neutrons, blocked by light elements such as hydrogen, which slow and/or capture them.

Galactic cosmic rays (not shown) consist of energetic charged nuclei such as protons, helium nuclei, and high-charged nuclei called HZE ions.

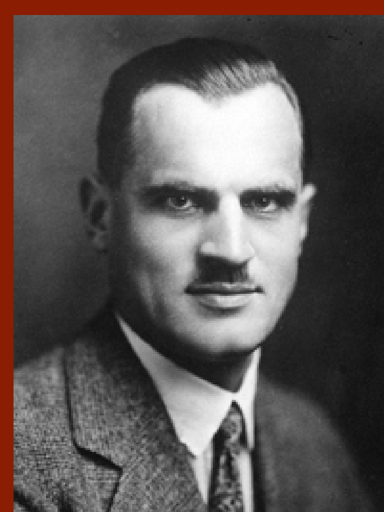


This NASA illustration shows that the Low Earth Orbits are relatively well protected below the inner and the outer belts, while GPS satellites and Geosynchronous orbits are on the rims of the outer belts.

The main emissions from the sun are electromagnetic radiation and a flow of charged particles called the solar wind. These particles carry both positive and negative charges, and collectively form what's called a plasma. Think of it as a diluted gas, but it can behave very differently because the particles are charged. The impact on a satellite and its onboard equipment may be a direct result of exposure to solar wind. However, it is important to understand that this radiation has indirect consequences on a spacecraft a well. For instance, residual oxygen from our atmosphere is ionized by solar radiation and impacts the outside materials of a space craft in LEO through chemical interactions.

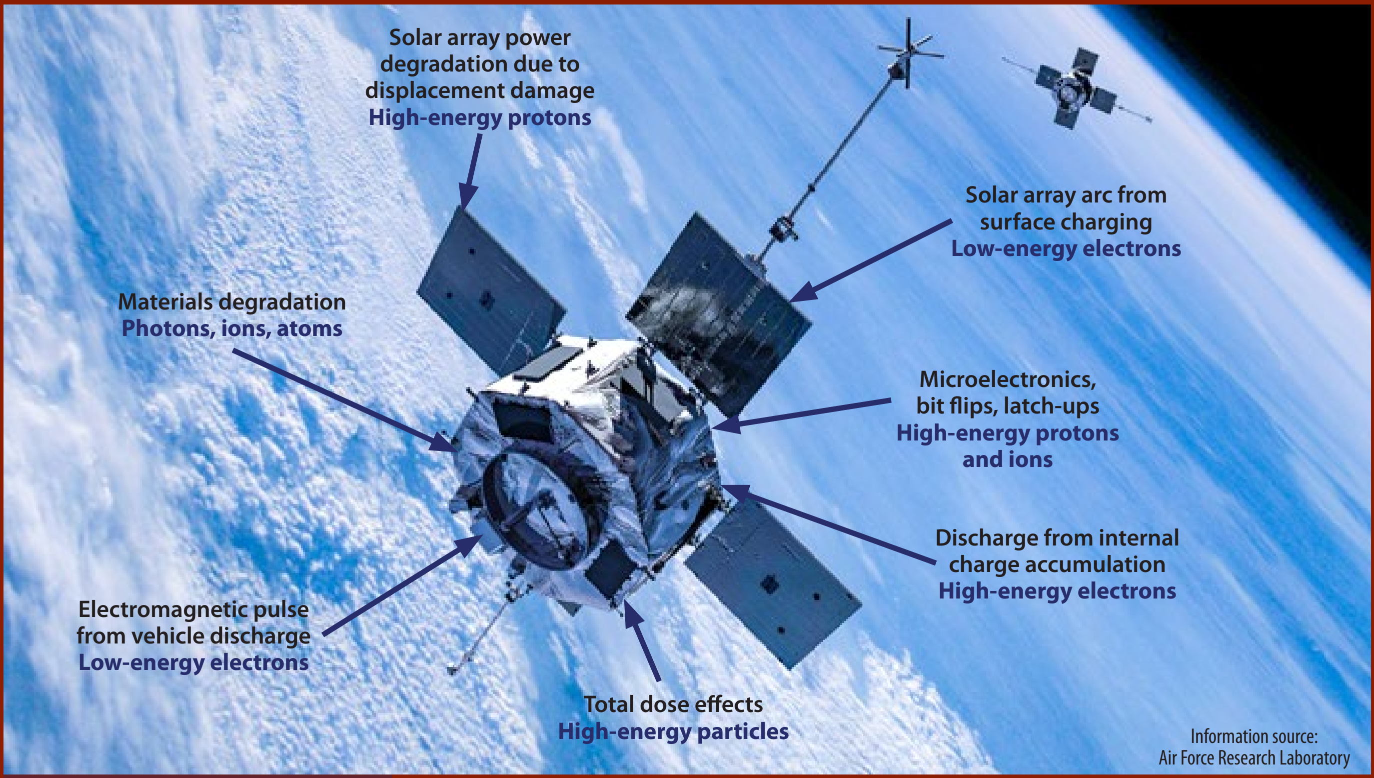
One way to parse the direct emissions from the sun is to focus on particle charge. This distinction is useful because charged particles interact strongly with matter and can be absorbed quickly (depending on their energy, or speed). The absorption will add a unit of charge to the material and may may trigger secondary emissions which must sometimes be taken into account.

Neutral particles and electromagnetic waves can still cause molecular or atomic changes in materials, but they can penetrate deeper into solid materials. Neutrons, for instance, will mostly interact with the nucleus of an atom, which is tiny, dense, and surrounded by a void. Electromagnetic particles (also called photons) must be parsed into bins of different energies. The higher the energy of a photon, the shorter its wavelength and the deeper it penetrates. This is easy to remember when you think of X-rays and UV light. X-Rays can penetrate through our bodies because they have much shorter wavelengths than UV rays. That's why in the illustration on the left you see some of the wiggles making it through the blue block of material and others not. The ones going deeper have a shorter wavelength. For the purpose of our conversation, the important aspect is how far do the particles penetrate, and how much potential damage will occur over time.



American physicist Arthur Compton (1892 – 1962) won the Nobel Prize for his discovery of the Compton Effect, which demonstrated the particle nature of electromagnetic radiation.

The most common effect of electromagnetic radiation (or photon impact) is the Compton effect. High energy photons (UV, X-ray, Gamma-ray) can interact with an electron orbiting an atomic nucleus, and provide it with a boost of energy sufficient to liberate it from its atomic confinement. What remains is an atom with a positive charge and a free electron. The Compton effect impacts the tenuous regions of



This picture illustrates some of the impact ionizing radiation and low-energy charged particles can have on a satellite.

earth's atmosphere in a similar manner. The charged ions and free electrons create a layer of conductive gas (plasma) in our upper atmosphere, called the ionosphere. LEO satellites at altitudes between 100 and 300 kilometers are in that zone. For these satellites, it's important to consider the exact orbit and their orientation with respect to the sun in order to truly assess the potential impact of charged particles on their surfaces. For example, higher concentrations of charged particles are present in the Van Allen belts closest to earth's magnetic poles, while lower concentrations exist in equatorial regions. This has a very practical impact on orbit the trajectories of LEO satellites, as they are relatively safe from charged particles except and if their orbits traverse the Van Allen belts.

Avoiding long transits through dense belts is an important consideration when engineers select the optimal orbit of a satellite. Sometimes there is no choice, a geosynchronous satellite above Central America will necessarily feel the impact of the outer belt and will have to be designed accordingly.

Material degradation due to radiation

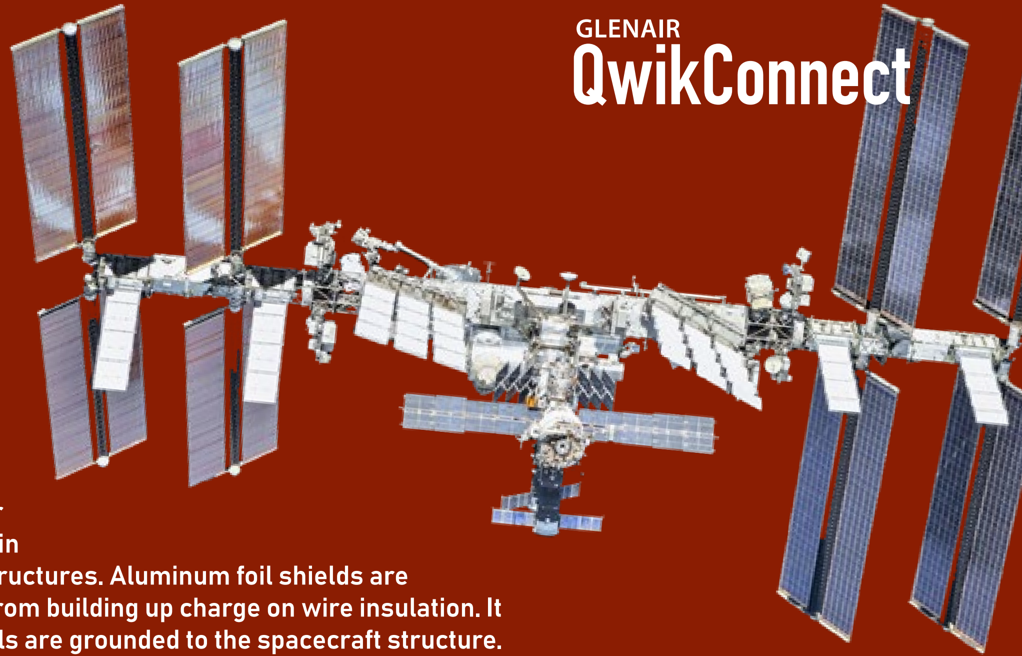
In terms of what damage particles can do, scientists employ a unit of measurement called the Rad, which measures how much energy was deposited by radiation into a unit of mass. It is the preferred unit when evaluating a material (how many Rads can it handle before degrading), or when comparing orbits, or calculating the lifespan of a spacecraft. Laboratories use electron beams and gamma rays from Cobalt 60 to simulate radiation exposure, again measured in Rads.

In some materials (optical fibers, semiconductors, dielectric insulators) it is also important to understand how fast the radiation is implanted into the matter. In these cases, we use either the Fluence (power per surface area—important for solar cells for instance), or the flux (particle count per unit time into an angle area).

We will consider the impacts starting from the outermost layers of the spacecraft. The most prevalent particle for those areas are low energy electrons. Low energy means they don't have enough speed to penetrate deep into the structures. When they get absorbed, they add a unit of negative charge to the material they collided with. If it's a metallic (or conductive) material, the additional charge is free to move around and will change the voltage balance of the spacecraft with its

Materials under test to determine potential damage from absorbed radiation, such as silicone-based microelectronics, are exposed to radiation doses measured in "Rads". Doses in excess of 100 mRads can result in material hardening and embrittlement, making them unsuitable for use in satellite applications.

environment ever so slightly. If the charge hits an insulating material, it will not be free to move around, and that insulator will build up charge with every electron that hits it in this area. When charges have nowhere to go, they accumulate, and before long, a voltage builds up and may be discharged, typically with an arc to a nearby conductor at a lower voltage. For this reason the outermost layer of a spacecraft needs to be conductive, or at least able to 'bleed' off charge fast enough so as to prevent a voltage build-up. This is particularly important for wires, since their outermost layer is non-conductive and they are often in close proximity to grounded metallic structures. Aluminum foil shields are a popular means to prevent electrons from building up charge on wire insulation. It is important to make sure that those foils are grounded to the spacecraft structure.



You may wonder, what happens if a spacecraft keeps accumulating electrons? Does that impact the electrical networks on board? How does one control the voltage when charge keeps accumulating on a ground structure? The answer is that unlike on earth, Satellites do not have an absolute ground. If we could tie a wire between earth ground and a satellite, we might measure a huge voltage difference. But since nothing on the spacecraft is tied to earth ground, the electronics 'don't know' that they are operating with a different zero volt reference than their cousins on earth. Think of it like the tide of an ocean; when boats float in the open waters, they don't feel the tides, and as long as they don't come close to shore, the height of the tide does not matter. When two spacecraft come in contact however, they do need to level out their ground structures in order to avoid an un-controlled discharge.

The surface of the spacecraft is also where most of the electromagnetic radiation hits. Most organic molecules suffer long-term damage from this radiation. They become brittle, shrink, and lose adhesion. In electrical systems, this can impact impedance.

As mentioned earlier, in low earth orbit we also have a large amount of ionized oxygen, ready to oxidize and add resistance to certain metallic surfaces like aluminum. For this reason, gold is the preferred choice for surface coverings. It is very resistant to corrosion, reflects a broad spectrum of electromagnetic radiation, is immune to absorbed radiation, and is an extremely good conductor. At NASA, the tongue-in-cheek answer to the question, "why is everything plated with gold on your satellites?" is, "because we didn't have enough budget to use solid gold!"

Satellite plating with gold is used when insulation alone is inadequate to protect the satellite from radiation from heat, light, and impact. Gold is effective in reflecting radiation away from the satellite, is a good heat and electrical conductor, and does not react to atomic oxygen.

Material	Acceptable Dose (Mrad)
Bipolar Power Transistors	0.2 Mrad
MOSFET Transistors (on SiC)	1 Mrad [1]
Schottky Diodes (on SiC)	1 Mrad [1]
Epoxy Resin	100 Mrad [2]
Kapton (polyimide)	400 Mrad [3]
Kynar (PVDF)—mild damage	10 Mrad [2]
Silicone rubber	1 Mrad [4]
Teflon (FEP)	0.1 Mrad [2]
Epoxy-Glass Laminates	10 Mrad [2]

Acceptable radiation doses for typical materials used in electronics. Measurements were performed using ^{60}Co Gamma radiation.

[1] Steffens et.al. RADECS 2017
[2] Hanks et.al. NASA-CR-1781, 1971
[3] Golliher et.al. NASA/TM-2001-210245
[4] NASA Langley SP-8053, June 1970

A table of acceptable radiation levels for a few popular materials used on spacecraft. Small semiconductor components will certainly have an additional aluminum shield around them.

APP NOTES

Interconnect Design for Radiation-Induced EMI/RFI Interference

In the previous arcticle, we discussed how radiation—in the event it penetrates into satellite materials—can cause embrittlement and other forms of degradation, potentially impacting the mechanical, physical, and even electrical (impedance) properties of mission-critical equipment including electrical wire interconnect systems. Now, let's turn to a second key issue of radiation in space: managing the surface charge build-up of electrons that can lead to EMI noise and signal degradation in electronic systems. As with mitigation efforts to reduce penetration damage from alpha, beta, and gamma radiation, design disciplines for EMI noise mitigation include laminate shielding of wiring, conducting unwanted interference to ground, and the use of filtering technologies at box I/O interfaces to attenuate high-frequency interference.

The many benefits of good shielding

Traditional interconnect and wire harnessing products have a strong design emphasis on electromagnetic shielding to prevent unwanted interferences. This can of course be the case on spacecraft as well, many electronic systems must interact and not interfere with each other while fulfilling their missions. In addition, the metallic shields on spacecraft will protect the layers below from radiation. They will further bleed off unwanted charge accumulations on various areas of the craft. Finally, in the event of a discharge, they provide a safe place for the current to go.

Space-grade materials and plating choices for EMI/RFI mitigation

As mentioned in the previous article, the most abundant element in Low Earth Orbit is atomic oxygen, which is in a highly reactive state and can produce serious corrosion of surfaces through oxidation. Critical electrical junctions must therefore be protected from corrosion with surface platings, typically either electroless nickel or gold in order to maintain the ground path and shielding characteristics necessary in the management of EMI. Glenair plating codes M and Z2 are appropriate for all aluminum shell connectors. The XM plating code is for Glenair composite thermoplastic connectors and backshell accessories. Plating code GME is reserved for ESCC-compliant backshells only. All of these plating codes are qualified for use in LEO applications.

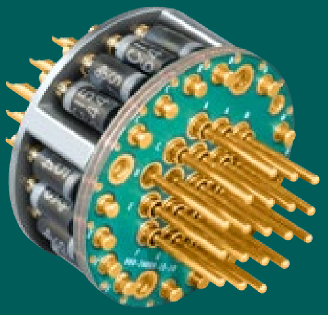
Space-Grade Finish Options		
Finish Code	Description	Specification
M	Electroless Nickel	SAE-AMS-26074 Class 3
XM	Electroless Nickel (Composite Only)	SAE-AMS-26074 Class 3
Z2	Gold Plated	ASTM B488
GME	Gold over Electroless Nickel	ESCC No. 3401 087 Para. 4.4.1

Ground plane connectors reduce both electrical equipment emissions and susceptibility to EMI

The use of a conductive metallic ground plane as a packaging option for shielded contacts and optical fiber links can effectively reduce the size of the penetration in the equipment enclosure Faraday cage. Metallic ground planes in connectors are typically made of aluminum, and the thickness is on par with the wall strength of the connector shell itself. Ground planes are always grounded to chassis.

Filtered EMI connectors effectively shield individual contacts / circuits

For discrete signal connector applications, an EMI filter package may be incorporated into the insert stack. This will in effect put a fine ground-mesh around every contact and prevent certain EMI events from disturbing the circuits in the box. The filter value should be selected so as to allow the desired signals that pass through, but block unwanted higher frequencies. The ceramic materials used in Glenair filtered connectors can be exposed to high doses of radiation without adverse effects. Transient Voltage Suppression (TVS)-equipped connectors prevent voltage spikes from discharge events from damaging delicate circuits inside electronic boxes. A correctly designed TVS diode can take millions of discharge events without damage. This is important because in space, discharge events may happen at regular and frequent intervals.



Aluminum wrapping versus braided shielding

Electrical cables exterior to the sealed/protected zone of a satellite need to be shielded—typically with wrapped foils or conductive braid materials—to extend the protective Faraday cage that is routinely established for electronic boxes and enclosures to interconnecting wires and cables. Elimination of apertures or gaps in braided wire shielding is critical, especially for high-frequency (short wavelength) EMI. In addition, the termination of wire shielding at the connector interface must be accomplished with good ground connections. As conductive adhesives on foil are notoriously bad, such materials should not be relied on for effective EMI/RFI shielding for critical systems in space flight applications.

Flexible braided shielding (left) is far less likely to develop gaps and apertures that can lead to entry/exit points for electromagnetic interference as compared to foil-wrapped assemblies

Ground fingers and springs on connectors enhance shielding effectiveness, reduce shell-to-shell resistance, and improve ground path

The use of robust connector ground springs and/or fingers can markedly reduce connector shell-to-shell resistance, and improve the ground path to eliminate surface conducted EMI. An EMI spring can be located on a plug or receptacle. Many types and approaches are employed, from simple dimpling on shells, such as found on inexpensive D-subminiature connectors (mystifyingly still specified in many satellite applications), to more sophisticated recessed springs in high-performance circulars. Ground fingers such as are used on the gold-plated D-Sub in the picture are particularly effective for critical space-flight applications.

BEHIND-THE-SCENES AT GLENAIR GSS

Premier Space-Flight Interconnect Component and Harness Manufacturing

Glenair has been making interconnect and wire harness shielding products since the dawn of manned space flight. At GSS, we have created a vertically-integrated space-grade component manufacturing, harness assembly, test, and integration operation. In building interconnect solutions for space—as opposed to other disciplines—we follow different rules of engagement. Every crimp joint, for example, is photographed. Every shield junction measured and recorded. Every electromechanical HDRM is 3D optical profilometer-inspected. Nothing is left to chance, everything is documented. These practices extend into every area of the operation, from our space-grade harness assembly group to our mechanical integration team, electromechanical device fabrication shop, and EGSE test rack and cable division. ESA/NASA IPC-certified staff provide value-added Engineering Base and 3D SolidWorks design, prototyping, and clean-room harness assembly. ISO 5 flow chamber (certified to ESD Standard 61340-5-1), with ample accommodation for large mock-up and integration projects.

Clean Room assembly with both environmental filtering and electrostatic discharge protection.

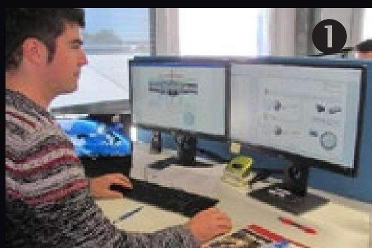
Glenair SPACE SYSTEMS

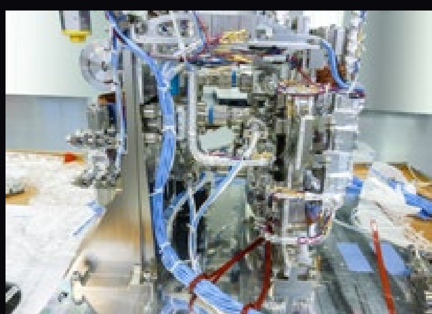
Wire Harness FABRICATION INTEGRATION

ESA and NASA IPC-Certified Wire Harness Assembly and Integration: Glenair has produced thousands of ground and space-flight shielded interconnect harness assemblies. Our GSS facility is optimized to serve both the European and NA markets with unique flight-ready systems and integrated assemblies that combine Glenair's unique range of high-performance interconnect components with our ESA/NASA IPC-certified harness assembly and clean-room integration capabilities.

GLENAIR SPACE SYSTEMS HARNESS DESIGN, PRODUCTION, AND INTEGRATION SERVICES

Glenair Space Systems GSS is an ESA/NASA IPC-certified interconnect wire harness assembly operation. Point-to-point and complex multibranch wire cable assemblies are produced to exact customer mechanical, thermal, electrical and radiation requirements and may be integrated on-site to both satellite mockups and space-flight systems in our 300 m² ISO 8 and ISO 6 clean rooms. A turnkey cable harness design and fabrication operation, Glenair Space Systems professionally manages projects from (1) engineering and documentation, to (2) wire harness prototype, to (3) mission simulation and test, to (4) clean-room integration.





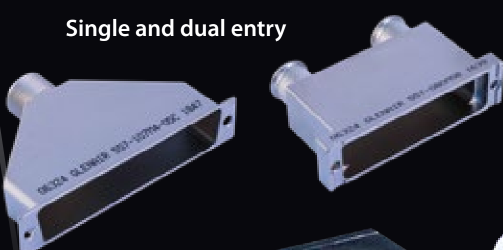
Complex integration and assembly of flight-grade wire harnesses

Harness integration into space payload electromechanical devices

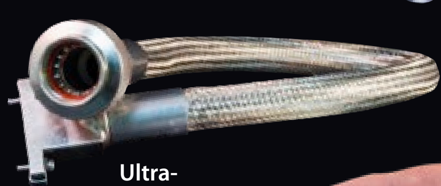
EMI shielded and open-wire bundle assemblies ready for flight

ESA-QUALIFIED D-SUBMINIATURE Backshells and Harness Shielding

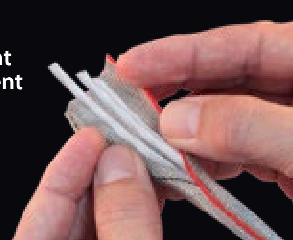
Single and dual entry



Composite split shell



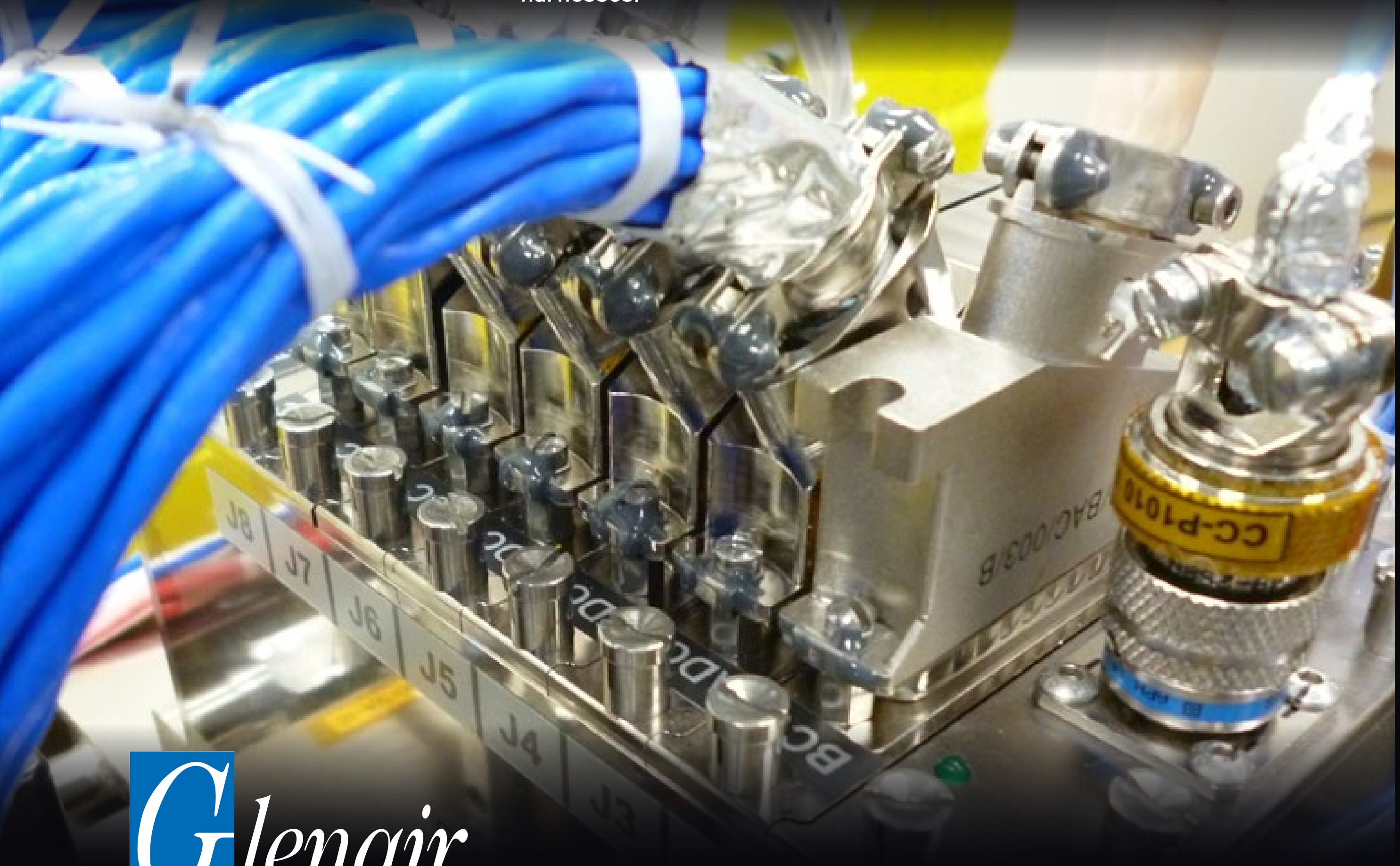
Ultra-lightweight microfilament tubular shielding



Side-entry shielding

Turnkey Electronic Ground Support Equipment (EGSE) Racks and Power / Data Test Cables

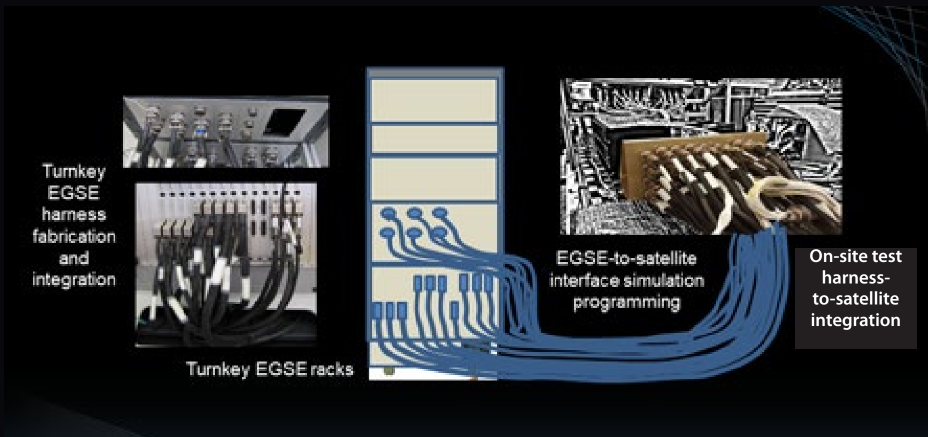
Turnkey fabrication of Electronic Ground Support Equipment (EGSE) test racks and cables is a unique capability of GSS—built to exact customer specifications and satellite test requirements. The extent of GSS support for ground simulation testing is absolutely unique in our industry and includes sourcing and construction of all necessary equipment and fabrication of required test cables and simulation harnesses.

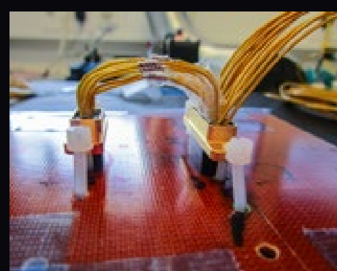


Glenair SPACE SYSTEMS

Glenair Space Systems Group in Salem, Germany, specializes in the construction of electronic test equipment, cables, and turnkey electronic ground support racks for satellites, simulation programming, and test. GSS assembly staff are ESA/NASA IPC-certified and can engineer and produce ground support equipment ranging from test harnesses and power / data distribution cables, to fully integrated test racks complete with interface / simulation programming. Signature ground support test racks and cable assemblies have been built for satellite programs including ExoMars, EML, EarthCare, BepiColumbo, Sentinel I, Sentinel II, Sentinel VI Jason, and others.

Examples of GSS-made EGSE racks and cables for satellite test/mission simulation



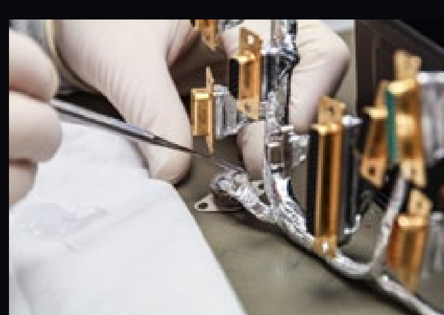


Example of ground support flat set harnessing used in developmental stages of satellite modeling, mockup, test, and mission simulation. Glenair Space Systems manages the entire process, from test cable design and fabrication to mockup integration.

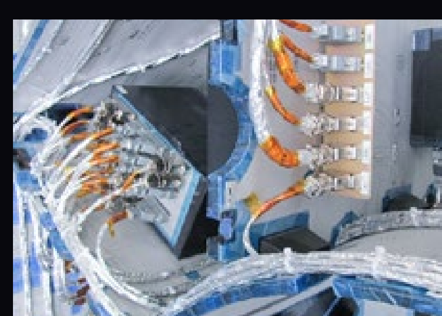
EGSE rack systems and interface simulation programming IAW customer requirements

ESA/NASA IPC-certified assembly staff perform all EGSE rack and cable assembly—from harness design and fabrication, to integration on prototype systems and mockups.

Hand assembly work performed by ESA/NASA IPC-certified assembly staff



Form, fit, and function of prototype harnesses using GSS-produced fixtures



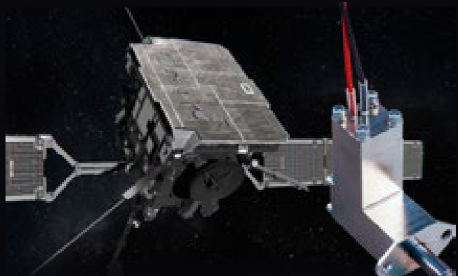
Cleanroom integration of shielded harnesses into satellite test racks

Space-Grade Electromechanical Device Manufacturing and Test

GSS-manufactured hold-down and release mechanisms (HDRM) as well as customer-bespoke electromechanical devices are manufactured in-house in our fully-integrated precision machining and metal fabrication center. All devices are clean-room assembled and inspected in a 3D optical profilometer.

HDRM housings precision-machined in-house with tolerances to 1 micron

Glenair® SPACE SYSTEMS



Space Mechanisms and HDRMs

GSS designs production and customer-bespoke space mechanisms: GSS is pleased to offer both our European and North American customers access to our innovative design, engineering, and machining capabilities for space-grade interconnect and electromechanical technologies including hold-down release mechanisms. Glenair Space Systems, Salem is equipped with a fully-integrated machining operation with capabilities to produce both highly miniaturized as well as larger form-factor components and structures. Our GSS-manufactured HDRMs with clean-room assembled actuators are a perfect example of this rare capability found only at Glenair.

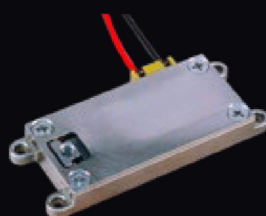
CUSTOMER-REFURBISHABLE, NON-PYROTECHNIC, SCALABLE HDRM TECHNOLOGIES

Connectorized and Mechanical-Release HDRM designs

Hold down release mechanisms are used to secure and deploy satellites and satellite appendages including solar arrays, reflector antenna, booms, and masts. Historically, release devices of this type have included explosive release nuts, bolt cutters, separation nuts, as well as wire and pyro cable cutters. Glenair non-explosive HDRMs employ a fusible wire-actuated nut technology that solves many of the problems associated with explosive hold down and release devices, including easy on-site refurbishment after test.

Certain designs are now manufactured by Glenair Space Systems in Salem, Germany. Glenair US-manufactured non-pyrotechnic and customer-refurbishable medium-duty HDRMs and pin pullers can ship to most customers worldwide without an export license, although light- and heavy-duty HDRMs do typically require one.

- Delivery options include connectorization and turnkey integration into shielded harness assemblies
- Lightweight materials, unique shapes and profiles
- Standard and non-standard mounting dimensions IAW customer requirements
- Scalable designs with as little as 5 lbs. (22 N) of release pre-load and as much as 20,000 lbs. (9000 N)
- Separation nut designs as well as pin pullers and pin pushers



Light-Duty HDRM
Side load bearing,
75 lb. release

Medium-Duty HDRM
Redundant,
1000 lb release

Heavy-Duty HDRM
Non-redundant,
20,000 lb. release

EXAMPLES OF ELECTROMECHANICAL DEVICES IN WHICH GLENAIR SPACE SYSTEMS HAS FABRICATED SOME OR ALL OF THE STRUCTURAL ELEMENTS AND INTEGRATED CABLING

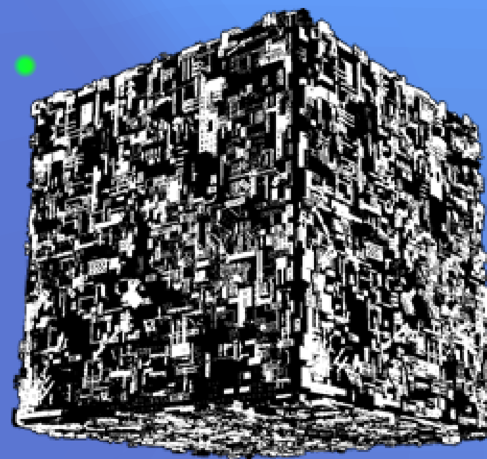
Complex motorized Ka-band antenna pointing mechanism with GSS-integrated harness assembly

Complex wave guide gain horn assembly with GSS-fabricated components and bespoke shielded wired harness assemblies

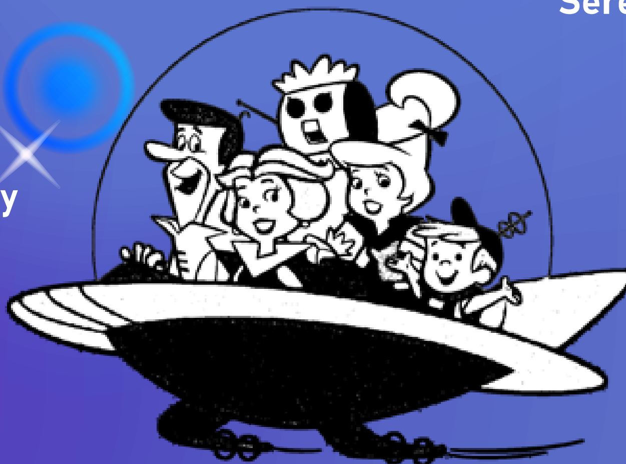
Example of an intricately-milled cover for an electromechanical device housing

Lost In Space?

Discovery One,
2001: A Space Odyssey

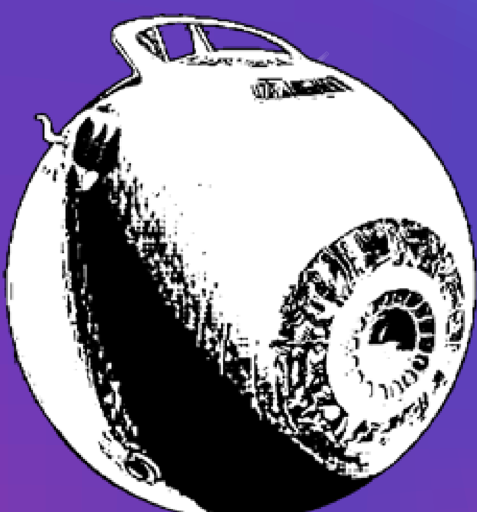


Serenity, Firefly

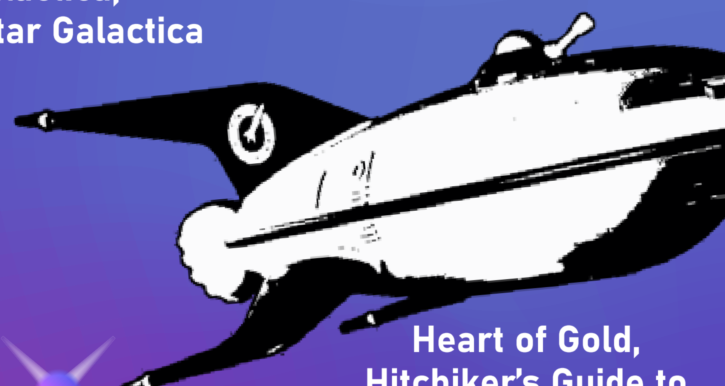


Galactica,
Battlestar Galactica

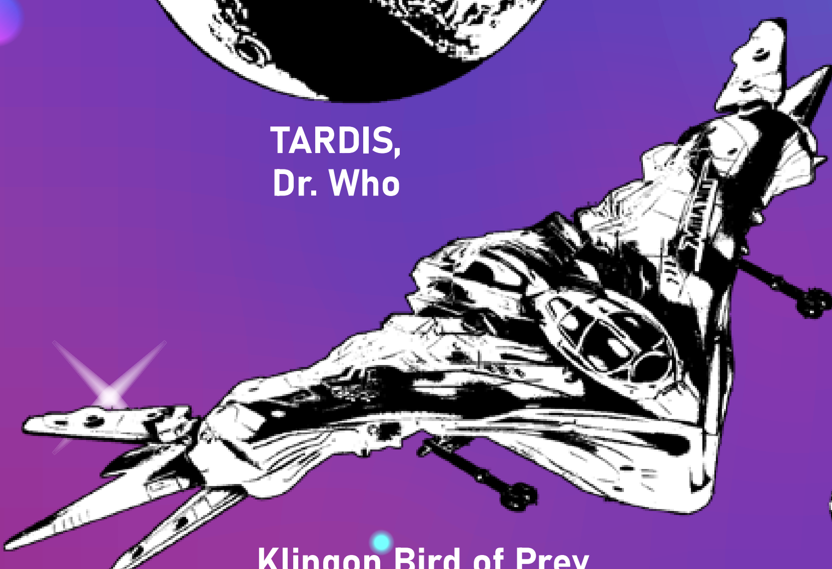
Millenium Fal
Star Wars



TARDIS,
Dr. Who

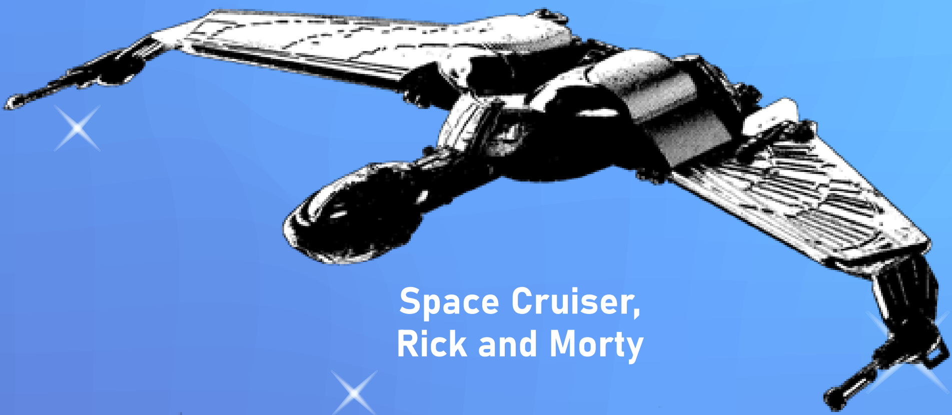


Heart of Gold,
Hitchiker's Guide to
the Galaxy

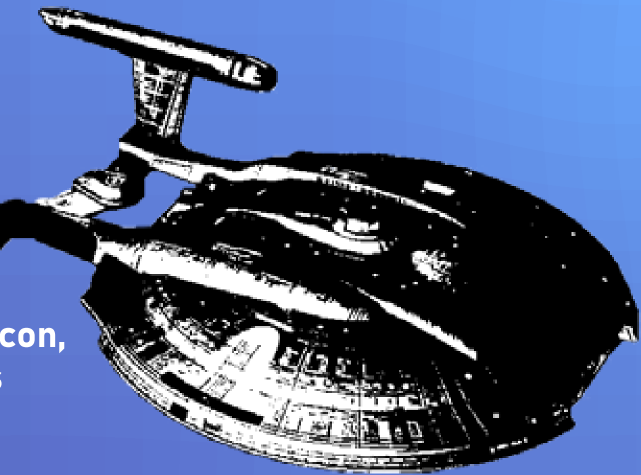


Klingon Bird of Prey,
Star Trek

Planet Express Ship,
Futurama

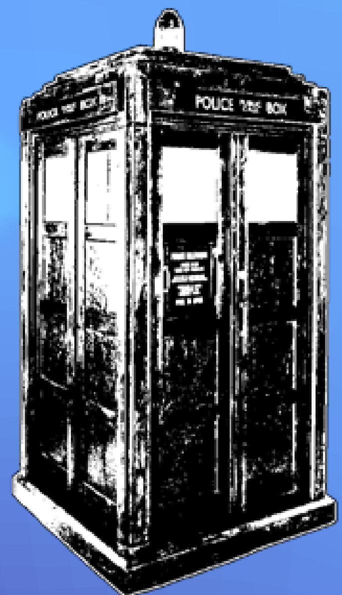


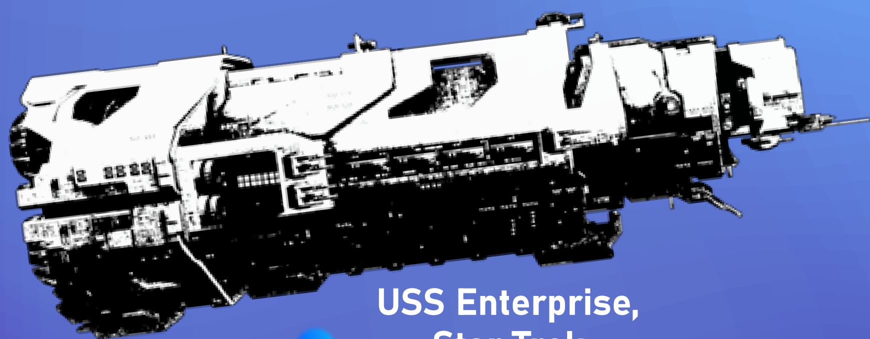
Space Cruiser, Rick and Morty



con,

Milano, Guardians of the Galaxy

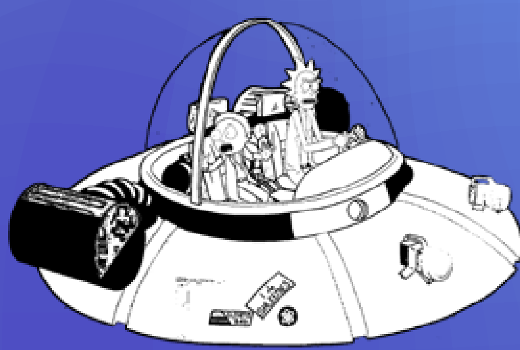




USS Enterprise, Star Trek

Borg Cube, Star Trek

Pillar of Autumn, Halo



ConvAirCar, The Jetsons

answers: www.glenair.com/qwikconnect

PROVEN-PERFORMANCE AND CURRENT-DAY FLIGHT HERITAGE

Glenair Interconnects and Assemblies in Next-Generation Manned-Flight Space Programs

A New Generation of Manned-Flight Interconnect Design-Ins

Glenair continues its long history of service in the manned space industry with a broad range of design wins on today's most mission-critical space applications. From blind-mate and lanyard-release connectors used in launch vehicles umbilical cables to special high-speed data link connectors designed for use on a next-generation space station build, Glenair is still the go-to partner for manned space interconnect engineering and manufacturing. As always, we offer our space industry customers not only discrete component technologies, but engineered assemblies that combine Glenair signature solutions into turnkey assemblies. This page spread provides a brief summary for a few of these design wins, followed up with data sheets for both these as well as some other proven-performance solutions—all with current-day or upcoming manned space flight heritage.

Assisted Separation Force and Lanyard-Release Quick-Disconnect Connectors, Cables, and Conduits for Rocket Launch Applications

Umbilical cables and ruggedized conduit assemblies used during rocket launch and inter-stage separation require sophisticated blind-mate and assisted-release connectors for reliable disengagement of the interconnect from the launch vehicle. Problems associated with poorly designed connectors of this type have long plagued launch events, even including for manned space programs. An original Titan (Missile C-2), for example, which had already been selected for use in early Gemini programs, suffered catastrophic failures due to non-separation of umbilical interconnects during launch. These problems have been completely resolved in both space agency and commercial launch systems through the use of purpose-designed MIL-DTL-38999 type connectors—Glenair SuperNine®—with accommodation for mating misalignment and spring-loaded assisted release. These solutions, as well as more conventional lanyard-release umbilical connectors, are supplied by Glenair for today's most mission-critical manned space launch systems.

The NASA Orion Multi-Purpose Crew Vehicle, artist concept. The future of human spaceflight?

High-Density Crimp-Contact Rectangular for Orion MPCV

The Orion Multi-Purpose Crew Vehicle (Orion MPCV) is a current generation partially reusable space capsule for NASA's human spaceflight programs. Capable of supporting a crew of six beyond low Earth orbit, it is equipped with solar panels, an automated docking system, and glass cockpit interfaces. Glenair has designed in a number of interconnect technologies onto Orion including a special space-grade Series 791 rack-and-panel rectangular that will be deployed throughout the vehicle. Microminiature form-factor rectangulars are typically only available with pre-terminated factory pigtail wiring. The Series 791 "Micro-Crimp" however, is a high-performance, precision machined, and crimp contact terminateable high-density rectangular connector—perfectly suited for space duty with a full range of unique design features including integrated ground springs, lobed polarization, and fully-shrouded wire termination zones.

Interconnect Design Partner for the Dream Chaser

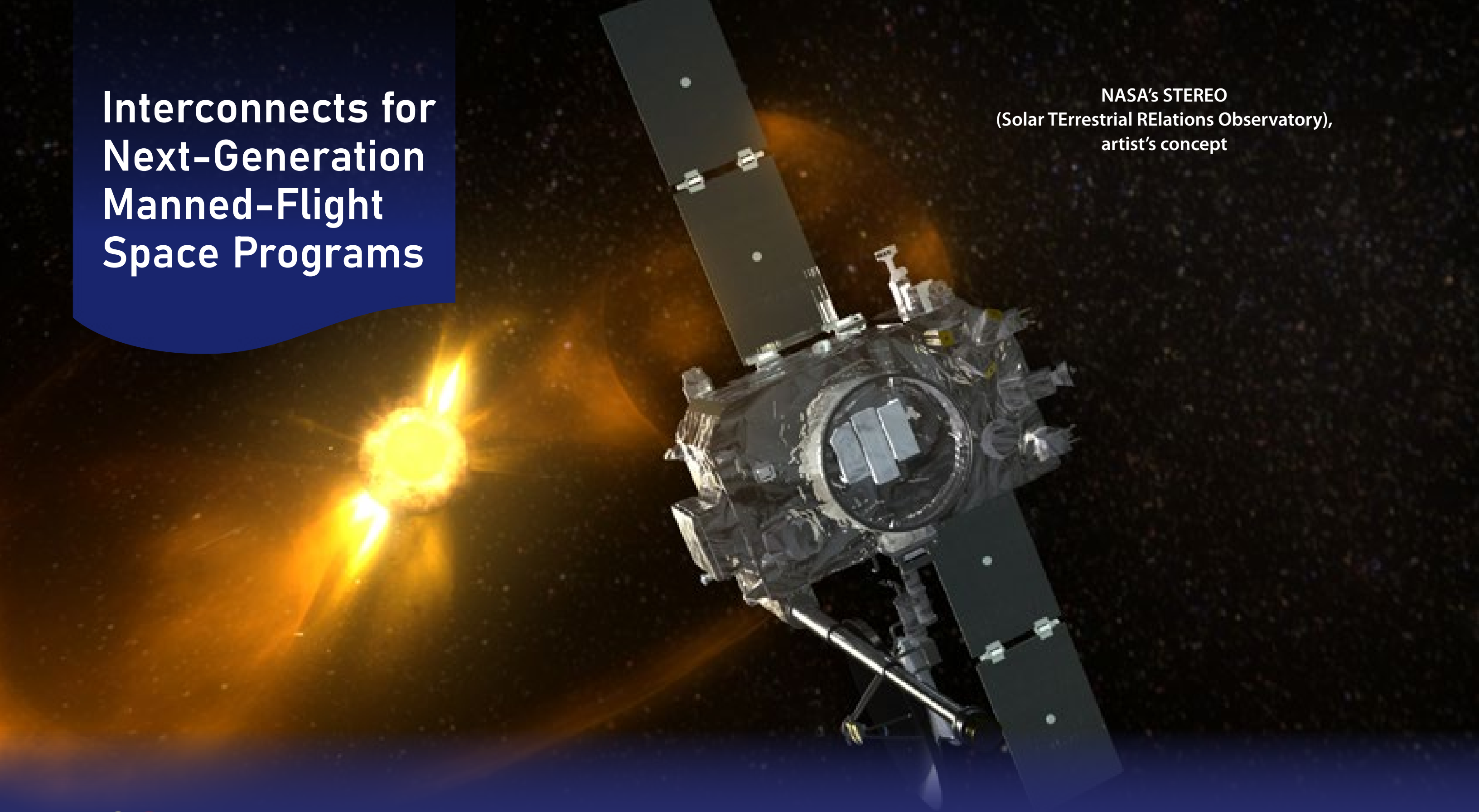
Glenair is the exclusive connector and cable supplier to the Sierra Nevada Corporation Dream Chaser, a reusable suborbital and orbital space plane. Originally intended solely as a crew transport vehicle, the Dream Chaser Cargo System is now slated to supply the ISS and autonomously land on conventional runways. Future crewed variants will be capable of carrying up to seven people to and from the Low Earth Orbit ISS. Glenair will supply a broad range of technology to Dream Chaser, most notably our lightweight microfilament braid ArmorLite™, which reduces the weight of critical wire shielding in the unpressurized zones of the space vehicle.

Canadarm as viewed from the International Space Station

High-Speed Data Links for Canadarm3

The Canadian Space Agency has sponsored the development of a multi-purpose robotic arm for use on the International Space Station to deploy, maneuver, and capture arriving payloads. Canadarm3 will be equipped with the Orbiter Boom Sensor System (OBSS), an instrumentation package of scanners and lasers used to inspect arriving spacecraft and payloads. Glenair high-speed Series 792 Micro-Crimp connectors and turnkey aerospace-grade cable assemblies with El Ochito® contact technology will support specified high-speed and high-definition video formats as well as 10Gb Ethernet protocols used on the arm. El Ochito® is a high-performance shielded contact technology that, in conjunction with its high-performance Series 792 connector packaging, will ensure reliable and uninterrupted datalinks from Canadarm3 to the ISS.

Interconnects for Next-Generation Manned-Flight Space Programs



NASA's STEREO
(Solar TErrestrial RElations Observatory),
artist's concept

SuperNine®

SPACE GRADE
NASA
ESA, JAXA
SCREENED

Blind-Mate Connectors

Umbilical Cable, Sealed, Assisted Kick-off, and Lanyard Release Quick-Disconnects

Blind-mate, fixed and float-mount interconnects for launch applications as well as satellite and payload deployment

Application: Glenair SuperNine® Series 253 blind-mate connectors are designed for use in space launch and satellite deployment applications, scientific payloads, interstage, timed release, and more.

- **Available in most symmetrical MIL-STD-1560 insert arrangements with contacts sizes from #23 to #8**
- **Selected materials offer low outgassing properties and high resistance to both corrosion and stress corrosion cracking**
- **Designed to withstand the rigors of launch and flight—including shock, vibration, thermal vacuum, acceleration, and temperature extremes**
- **Standard accessory threads and teeth per MIL-DTL-38999 accommodate a wide range of backshell accessories**
- **Crimp-removable contacts standard. PC tails, dual-flange standoffs, hermetically sealed, and custom blind-mate configurations available**

SPACE-GRADE BLIND MATE

SuperNine®

GLENAIR **QwikConnect**

Float-mount and adjustable separation force connectors

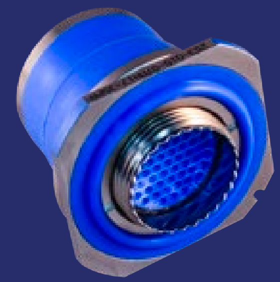
MIL-DTL-38999 Series III type, environmental, crimp contact

CRITICAL MECHANICAL FEATURES OF BLIND-MATE AND ADJUSTABLE SEPARATION FORCE (ZEF) CONNECTORS

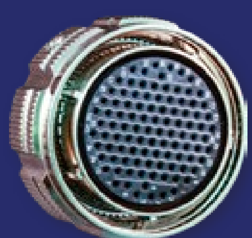
Roll-off nose: allows for the smooth disconnection of blind mate plugs and receptacles.

Float mounting: allows for coplanar movement of the receptacle during mating, preventing contact and shell damage.

Misalignment accommodation: Radial, axial, and angular misalignment during mating is accounted for with integral wave springs.



Sealing: Misalignment accommodation makes environmental sealing difficult. The problem is solved with auxiliary external seals.



EMI shielding: Glenair incorporates ground springs in receptacle connectors and grounding fingers in special coupling nut-equipped plugs to optimize 360° shell-to-shell continuity.

Assisted separation force: Adjustable kick-off style with spring-loaded posts and an adjustment ring to calibrate separation force. A second style uses **wave springs** on the shell body.

LANYARD-RELEASE QUICK-DISCONNECT CONNECTORS FOR LAUNCH UMBILICAL CABLE APPLICATIONS

AS81703 space-grade lanyard release push pull mated pair with special order band and boot platform

Jam-free push-on, pull-off technology for reliable fail-safe axial pull and release

Interconnects for Next-Generation Manned-Flight Space Programs

SERIES 791™ SEVEN NINETY-ONE

SPACE GRADE NASA ESA, JAXA SCREENED

HIGH PERFORMANCE

Series 791

Polarized / keyed shells prevent mis-mating and allow designers to specify identical layouts side-by-side without risk of circuit damage

The next-generation micro-miniature rectangular connector for demanding aerospace applications. Originally designed for NASA's Orion project, the 791 is qualified for manned space flight. The 791's small size and blind mate capability make it a perfect choice for 2U and 3U electronics modules. Space applications include radars, satcom, exoatmospheric vehicles, flight avionics, power distribution units, and satellite instrumentation.

Prevent mis-mating with Mod Code 555 special keying option

- **Next-generation small form factor aerospace-grade rectangular connector approved for manned space flight**
- **Scoop-proof recessed pin contacts**
- **37 arrangements; 12 shell sizes; size 23, 16, 12 and 8 contacts**
- **Environmental**
- **EMI shielded**
- **Guide pins for blind mate modules**

SERIES 791 MICRO-CRIMP

Next-generation micro-miniature rectangular for demanding aerospace applications

Save Size and Weight with Series 791 Connectors

The Next Generation Micro-miniature rectangular Connector for Demanding Aerospace / Space Flight Applications

About The Series 791

The Series 791 is an aerospace-grade micro-miniature rectangular connector with EMI protection and environmental sealing. Originally developed for NASA's Orion capsule, The 791 is qualified for manned space flight and is ideal for radars, weapons systems and avionics gear.

The Series 791 is available either with crimp pins or with printed circuit terminals. Machined aluminum alloy shells feature dual lobes for polarization. Contact sizes range from size 8 to size 23 in 37 arrangements. Pin contacts are recessed to prevent scooping damage while mating. Crimp contacts conform to M39029 requirements and are rear release.

An optional ground spring reduces susceptibility to EMI problems. Fluorosilicone face seals and wire grommets prevent moisture and contamination. Panel mount versions are available with an O-ring, or for improved panel bonding, a metal spring.

Board mount versions include straight or right angle terminals. Right angle PCB connectors feature an aluminum shroud covering the terminals.

Hardware options include screwlocks, jackscrews or guide pins for blind mate applications.

M-17P17 with size 16 contacts

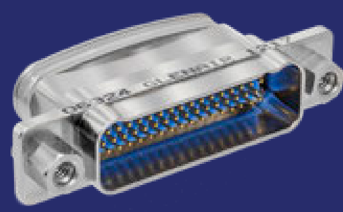
- **Coax, twinax, quadrax and El Ochito octaxial contacts**
- **Rugged aluminum shell with dual polarizing lobes**
- **Straight and right angle printed circuit board mounting**

Shell size A – the smallest 791

- **-65°C to +150°C**
- **Panel mount versions with O-ring or EMI spring**

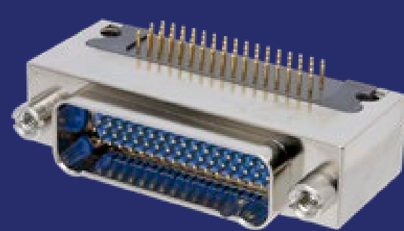
Series 791 with MT ferrules

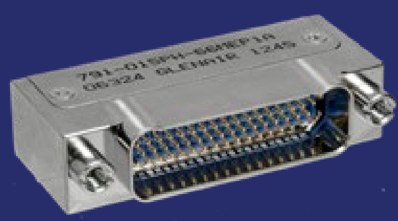
- **Ruggedized small form-factor, high-density MT fiber optic solution**
- **Optimized for use with parallel optic transceivers in ribbon or round cable applications**



Integral backshell cable connector

- **Available with integral oval band porch or backshell accommodation**
- **Superior EMI shell-to-shell performance compared to M24308**
- **SAE AS39029 crimp-and-poke contacts**





Series 791 with MT ferrules

- **Epoxy sealed board-mount configurations, straight and 90°, with and without panel mount sealing**
- **Internal ground spring**
- **Fully shrouded shells for superior EMC performance compared to M24308**

Interconnects for Next-Generation Manned-Flight Space Programs

Series 792 Crimp-Contact Rectangular

El Ochito brings high-speed data-rate performance to the Glenair Series 79 rectangular connector family. Size 8 cavities accept all styles of El Ochito® shielded octaxial contacts making it a perfect choice for radars, HD cameras, mission computers, remote sensors, displays, digital communications gear, and more.

El Ochito®

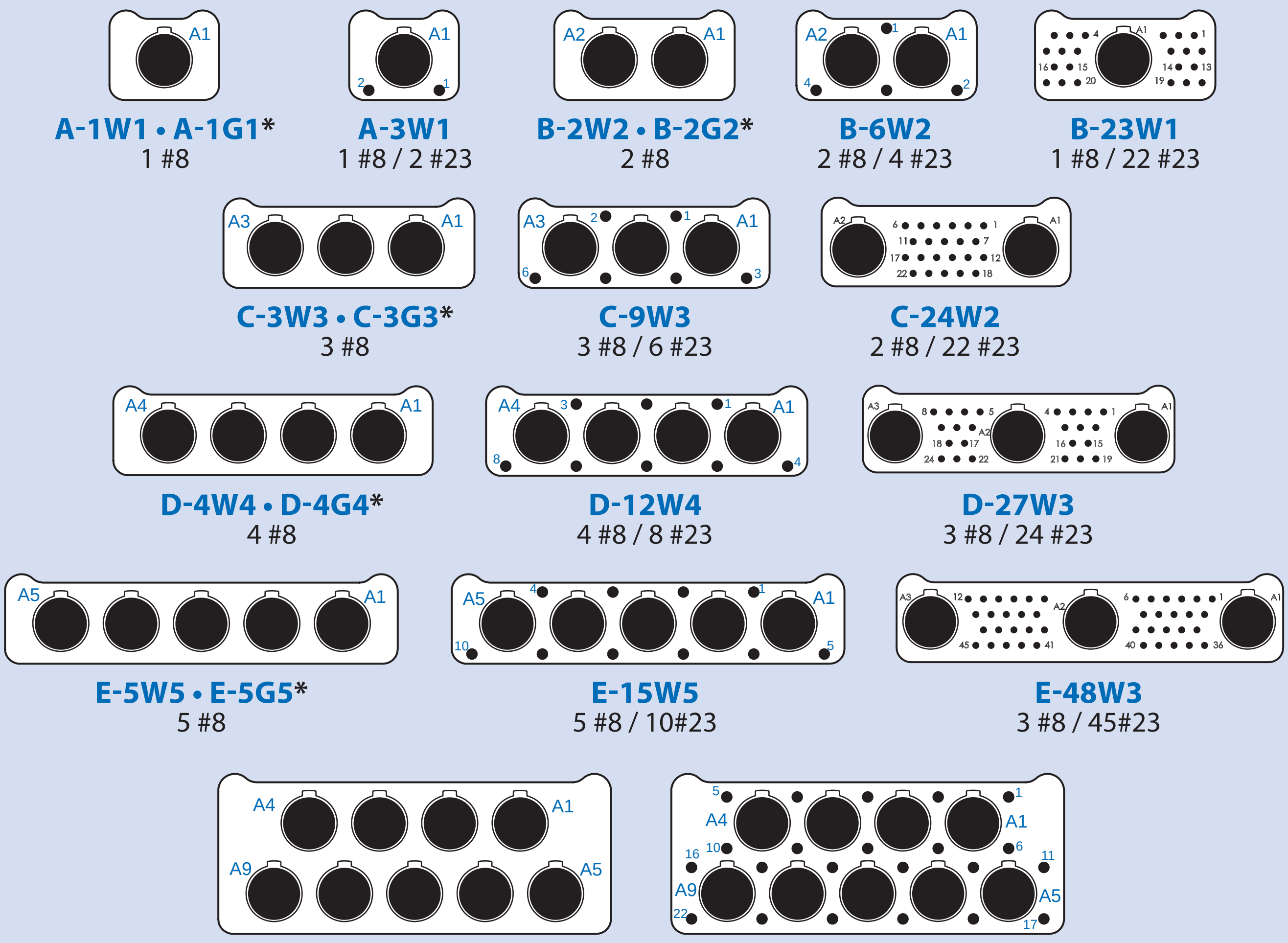
- High-speed Ethernet, USB 3.0, HDMI, and DisplayPort
- PCB-mount and cable connectors
- Scoop-proof interface
- 16 arrangements and 6 shell sizes
- Precision-machined dual-lobe polarized shells
- Environmentally sealed
- Integrated EMI shielding and grounding
- Blind mating

The next-generation micro miniature rectangular for high-speed space / aerospace applications

DESCRIPTION	REQUIREMENT	PROCEDURE / NOTES
Operating temperature	-65° to +175°C	EIA-364-32 Test Condition IV
Current rating	1.5 Amps (datalink contacts) 5 Amps (Size #23 contacts)	Datalink contacts tested: El Ochito® White
DWV (sea level)	750 VAC (Size #23 contacts) 1000 VAC (datalink contacts)	EIA-364-20
Insulation resistance	5000 MΩ minimum	EIA-364-21
Contact resistance, 25°C	55 millivolt maximum	EIA-364-06, 1.0 A test current, #24 AWG wire

DESCRIPTION	REQUIREMENT	PROCEDURE / NOTES
Shell-to-shell resistance	2.5 millivolt maximum	EIA-364-83
Shielding effectiveness	<u>Frequency</u> / <u>Attenuation dB</u> 100 / 75 1000 / 50 3000 / 44 6000 / 38 10000 / 35	EIA-364-66
Ingress protection	IP67 rating	IEC-60529

Series 792 Contact Arrangements



A-1W1 • A-1G1* 1 #8

A-3W1 1 #8 / 2 #23

B-2W2 • B-2G2* 2 #8

B-6W2 2 #8 / 4 #23

B-23W1 1 #8 / 22 #23

C-3W3 • C-3G3* 3 #8

C-9W3 3 #8 / 6 #23

C-24W2 2 #8 / 22 #23

D-4W4 • D-4G4* 4 #8

D-12W4 4 #8 / 8 #23

D-27W3 3 #8 / 24 #23

E-5W5 • E-5G5* 5 #8

E-15W5 5 #8 / 10#23

E-48W3 3 #8 / 45#23

F-9W9 • F-9G9* 9 #8

F-31W9 9 #8 / 22#23

Contact Key

Size #8

Size #23

* Grounded aluminum insert

Interconnects for Next-Generation Manned-Flight Space Programs

LIGHTWEIGHT

ArmorLite™

Microfilament nickel-clad stainless steel EMI/RFI braided shielding for harsh electromagnetic radiation applications. ArmorLite™ is an expandable, flexible, high-strength, conductive stainless steel microfilament braid designed for weight reduction and superior flexibility compared to conventional wire shielding as well as superior coverage compared to foil tape wrapping. ArmorLite™ is radically lighter than virtually any other braided shielding solution. By way of comparison, 100 feet of 5/8 inch ArmorLite™ is more than four pounds lighter than standard 575 A-A-59569 shielding.

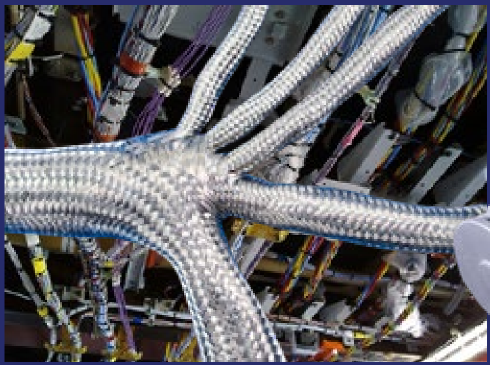
- **Ultra-lightweight EMI/RFI braided sleeving for high-temperature applications -80°C to +260°C**
- **Microfilament stainless steel: *70% lighter* than NiCu A-A-59569/QQB575**
- **Outstanding EMI/RFI shielding and conductivity**
- **Aerospace environment qualified**
- **Superior flexibility and "windowing" resistance: 90 to 95% optical coverage**
- **70,000 psi (min.) tensile strength**
- **Best performing metallic braid during lightning tests (IAW ANSI/EIA-364-75-1997 Waveform 5B)**

LIGHTWEIGHT, FLEXIBLE

ArmorLite™ Microfilament Braid for EMI/RFI Shielding Applications

GLENAIR **QwikConnect**

Side-entry versions of ArmorLite, called MasterWrap™, are available for interstices reinforcement, spot coverage, and repairs.



ArmorLite may be overbraided at the factory directly to multibranch assemblies, or supplied in a tubular format for on-site installation.

Using ArmorLite™ in place of wrapped foil shielding improves both overall cable coverage as well as penetration resistance to Low Earth Orbit electromagnetic radiation

DESCRIPTION	REQUIREMENT	PROCEDURE	REPORT
Operating Temperature	-80°C to +260°C	(85% Shielding effectiveness 1000 hours)	ARM-103
Braid Resistivity test, Pre and Post	Test pre/post–5 cycles–minimal disparity per spec.	EIA-364-32D IAW AS85049	ARM-110/1
Surface Transfer Impedance	Glenair Qual. Test Plan ATP-194	Line injection IEC96-1 A.5.5.3 30KHz - 2.5 GHz mod	ARM-104
Shield Effectiveness Test, Pre and Post	Glenair Qual. Test Plan ATP-194	Line injection IEC96-1 A.5.5.3 30KHz - 2.5 GHz mod	ARM-104
Tensile/ Pull Strength	220 lbs. (min.). No anomalies within 8% - 10% of pre test for variable sizes	Glenair ATP- 183. 0 lbs. to 90 lbs, to 150 lbs, to 220lbs @ speed of 0.25 inches/min	ARM-105
Lightning Current Test	Glenair Qual. Test Plan 191/ DC resistance/ voltage criteria per DO-160F Level for 3 sizes up to 30Ka.	ANSI/EIA-364-75-1977 Wave Form 5B SAE/ARP5416 Section 6.3 Waveform 1, 3 (1, 10MHz) and 5A	ARM-110 ARM-112
Vertical Flammability	Self extinguishing ≤ 2 sec. Burn length 0.1 inch. max. Dripping 0.0 seconds.	14 CFR part 25.853 (a) AMdT25-116 Appendix F Part I (a) (1) (ii)	ARM-101
Mass Loss and Collected Volatile Condensable Materials	Total Mass Loss (TML) ≤1.0% Collected Volatile Condensable Matl.(CVCM) ≤.1%	ASTM E-595	ARM-102
Salt Spray Test	DC Resistance IAW AS85049 .5 milliohm. No evidence of base metal on braid	ASTM B117-09 Sodium Chloride 5% 500 Hrs	ARM-100
Vibration Resistance	EAI Test Report 33247. DO160 section 8 Cat. R Vib. Curves E1	DO-160F RTCA/DO-160F, Section 9, Fig. 8-4. Curve E1. - 3 sizes – 3 hours on each axis.	ARM-111
Thermal Shock Cycling test and Resistivity	No adverse effects in visual inspection or resistance after 50 cycles	EIA-364-32D, Table 3 Test condition V -75°C to +215°C	ARM-113
Abrasion and Plating test	DC Resistance IAW AS 85049. Glenair internal QTR-003	ATP 180 20 continuous @ 6 cycles/min. over 3 arms with .030 radiused edges	ARM-107
Fluid Immersion Test	Broad material compatibility	Customer/AS4373D method 601 Mod	ARM-106
Flex Test	2 Cycles: starting 0° over vertical ctr. line across to 180° cycle. Total cycles of 25633	Glenair ATP 179	ARM-112

Interconnects for Next-Generation Manned-Flight Space Programs

Astronauts work in tandem to remove debris and lubricate the starboard Solar Alpha Rotary Joint on the STS-126 mission

Series 806 Mil-Aero Connectors

Innovative design meets key performance benchmarks for harsh vibration and shock, as well as for aggressive voltage ratings and altitude immersion standards. Glenair high-density microminiature circulars are designed-in on today's signature crewed space vehicle.

SAVE SIZE AND WEIGHT WITH SERIES 806 CONNECTORS

Series 806 Mil-Aero
Smallest Size
.500 In. Mating Threads
3 #20 Contacts or 7 #22 contacts

MIL-DTL-38999
Smallest Size
.625 In. Mating Threads
3 #20 Contacts or 6 #22 contacts

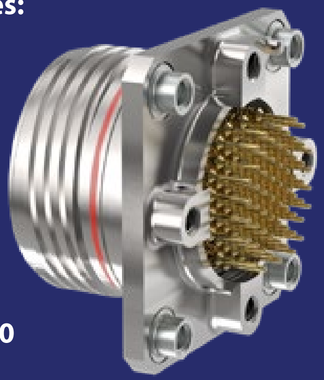
- **Next-generation small form factor space-grade circular connector**
- **Superior environmental, electrical and mechanical performance compared to industry-standard solutions**
- **High density 20HD and 22HD crimp contact arrangements as well as accommodation for size #8 El Ochito contacts**
- **Glass hermetic, lightweight aluminum hermetic, and filtered versions**
- **+200° C temperature rating**

Series 806 Mil-Aero Ultraminiature Circular Connectors

GLENAIR **QwikConnect**

for harsh space applications IAW MIL-DTL-38999

SERIES 806 MIL-AERO: FEATURES / SPECIFICATIONS



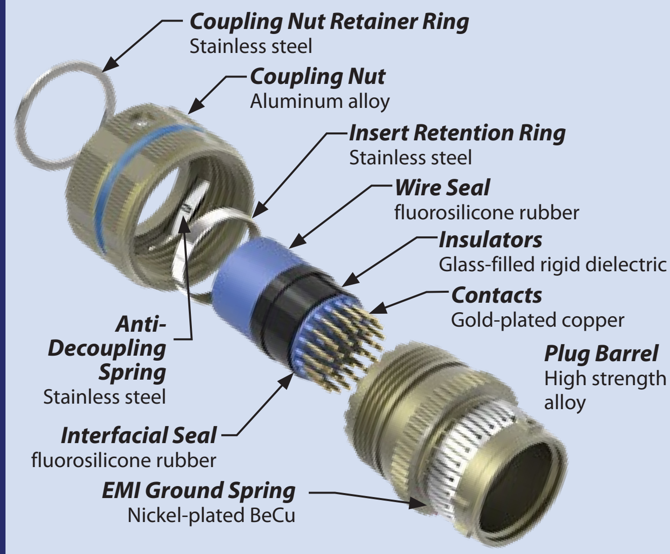
- **Supported wire sizes:**
  #20HD contacts 20–24 AWG
  #22HD contacts 22–28AWG
- **Dielectric withstanding voltage**
  #20HD layouts: 1800 Vac
  #22HD layouts: 1300 Vac
- **Reduced pitch triple-start modified anti-decoupling stub ACME mating threads**
- **“Triple ripple” wire sealing grommet (75,000 ft. rated)**
- **Integral Nano-Band shield termination platform**
- **EMI shielding effectiveness per D38999M para. 4.5.28 (65 dB min. leakage attenuation @ 10GHz)**
- **10,000 amp indirect lightning strike**
- **MIL-S-901 Grade A high impact shock**

AVAILABLE LIGHTWEIGHT ALUMINUM “CODE RED” HERMETICS

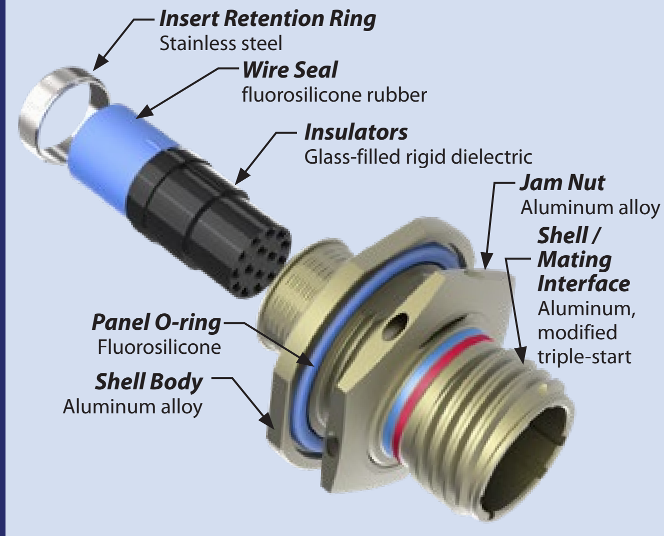
CODE RED is a lightweight encapsulant sealing and assembly process with 50% package-weight savings compared to glass-to-metal seal Kovar/stainless steel solutions. Non-outgassing CODE RED (IAW NASA/ESA) provides durable hermetic sealing with $1X10^{-7}$ leak rate performance. Gold-plated copper contacts deliver outstanding low-resistance current carrying capacity.

CODE RED

SERIES 806 MIL-AERO PLUG

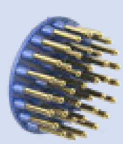
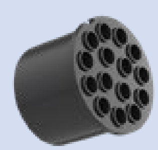
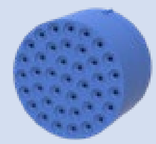


SERIES 806 MIL-AERO RECEPTACLE



SMALLER AND LIGHTER WITH EQUAL D38999 PERFORMANCE?

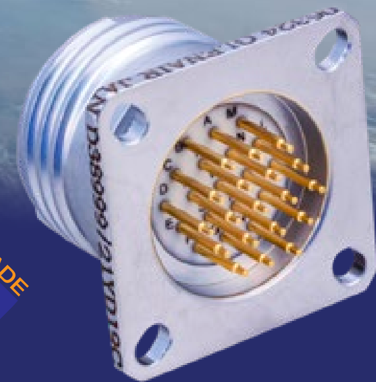
High-Density Layouts	***“Top Hat” Insulator***	***Triple Ripple Wire Seal***
Twice as many contacts in a smaller package	High voltage rating, foolproof alignment	Reliable 75,000 ft. altitude immersion

Interconnects for Next-Generation Manned-Flight Space Programs


Photo credit: NASA

SPACE GRADE
NASA
ESA, JAXA
SCREENED



Best-of-Class Hermetic Seal Connector Design

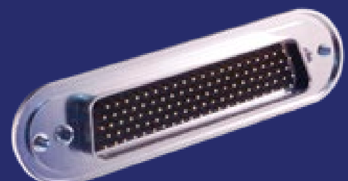
Resolve gas, moisture and particle ingress problems with advanced-performance glass- and encapsulant-sealed hermetic connectors

- **Superior pressure resistance to 32,000+ PSI**
- **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}**

CODE RED

LIGHTWEIGHT HERMETIC SEALING

Lightweight hermetic encapsulant sealing solution with 1X10^{-7} leak rate performance. Available today in Mighty Mouse 806 Mil-Aero, M24308/9 D-Sub and D38999/23



Aluminum shell CODE RED hermetic connectors and copper contacts reduce weight and improve electrical performance compared to heavier-duty glass-to-metal seal hermetic solutions

ADVANCED PERFORMANCE

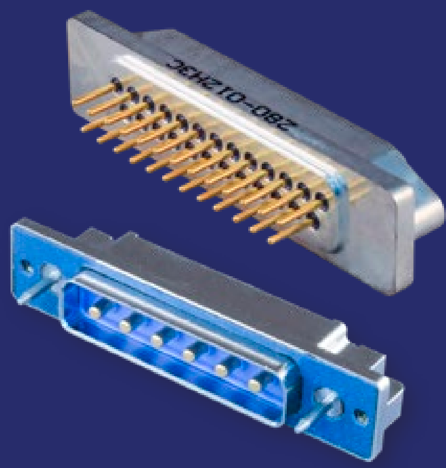
Glass-Sealed Hermetic Connectors

GLASS-SEALED
Hermetic
CONNECTORS

GLENAIR
QwikConnect

UNIQUE HERMETIC OFFERINGS AND CATALOG (COTS) SOLUTIONS

Coax, Triax, Quadrax and hybrid-contact layouts



Rectangular hermetics including Series 28 HiPer-D and Series 79

El Ochito high-speed octaxial contacts in a lightweight CODE-RED sealed bulkhead feed-thru

Triax hermetic

Hermetic Sav-Con Feed-thrus and Gender Changers

Dual-flange PC tail hermetic

Hermetic with crimp-removable contacts

Hermetic bulkhead penetrators

Hermetic receptacles with integrated band porch

SuperFly® Nanominiature Circular Connectors and Cordsets

PREWIRED CABLE CONNECTORS AND SOLDER CUPS

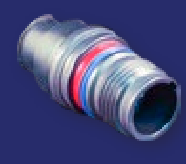
Cable plug, pigtail wires

Cable receptacle, pigtail wires

Front panel mount receptacle, pigtail wires

Rear panel mount receptacle, pigtail wires

Cable plug, solder cup



Cable receptacle, solder cup

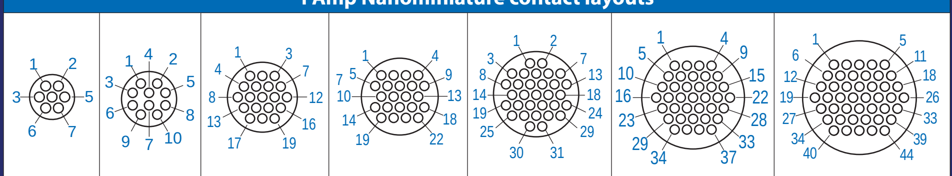
In addition to PCB termination and prewired pigtails, SuperFly is also available in ready-to-use overmolded or overbraided cordsets. Wire options include ultraflexible GhostWire or impedance-controlled twisted pairs for high-speed applications.

- High vibration and shock qualified
- Hybrid contact layouts: 5 Amp, 3 Amp, and 1 Amp
- High density, small form-factor
- Robust EMI shielding
- Designed for high speed data applications
- Pre-wired, epoxy-sealed cordsets
- Straight and 90° PC tail receptacles
- 27 Tooled contact arrangements
- Front or rear panel mounting
- Aluminum or stainless steel with space-grade plating
- Accepts #22 to #32 AWG wire

CONTACT ARRANGEMENTS

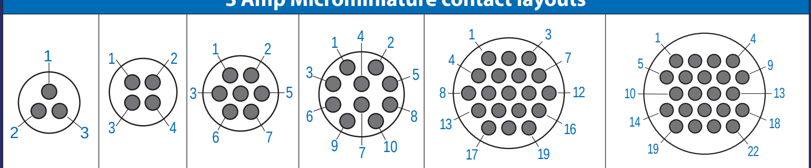
Series 88 SuperFly connectors are available in 27 contact arrangements with 1 Amp, 3 Amp, 5 Amp contacts, and mixed-contact hybrid arrangements—all optimized for smallest possible Size, Weight and Power (SWaP)

1 Amp Nanominiature contact layouts



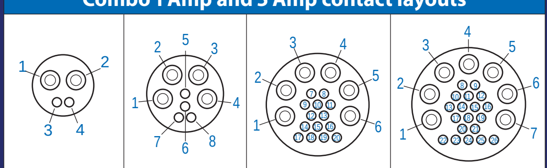
B7N	C10N	E19N	F22N	G31N	H37N	J44N
(7) 1A	(10) 1A	(19) 1A	(22) 1A	(31) 1A	(37) 1A	(44) 1A

3 Amp Microminiature contact layouts



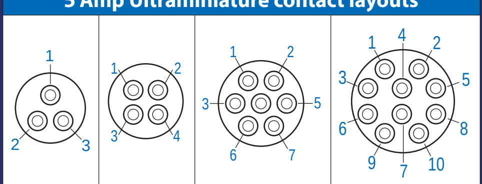
D3M	E4M	F7M	G10M	K19M	L22M
(3) 3A	(4) 3A	(7) 3A	(10) 3A	(19) 3A	(22) 3A

Combo 1 Amp and 5 Amp contact layouts



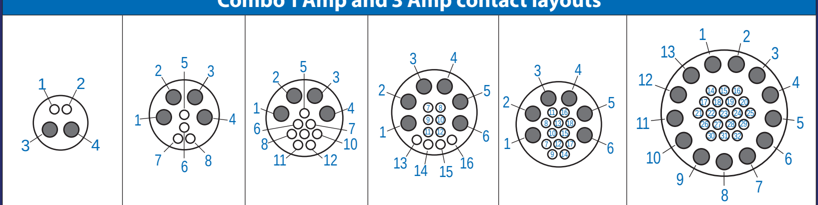
D2W2N	F4W4N	H6W14N	J7W19N
(2) 1A, (2) 5A	(4) 1A, (4) 5A	(14) 1A, (6) 5A	(19) 1A, (7) 5A

5 Amp Ultraminiature contact layouts



E3W	F4W	G7W	H10W
(3) 5A	(4) 5A	(7) 5A	(10) 5A

Combo 1 Amp and 3 Amp contact layouts



C2M2N	E4M4N	F4M8N	G6M10N	G6M12N	K13M19N
(2) 1A, (2) 3A	(4) 1A, (4) 3A	(8) 1A, (4) 3A	(10) 1A, (6) 3A	(12) 1A, (6) 3A	(19) 1A, (13) 3A

Outlook

Distance Gives Perspective

It's been well over 50 years since the Apollo 8 spacecraft put astronauts Frank Borman, Jim Lovell, and Bill Anders in orbit around the moon. In all the excitement that led up to that flight, I most recall the buzz about seeing the dark side of the lunar landscape for the first time in human history. What a revelation it was that the biggest take-away from Apollo 8 instead turned out to be the iconic "Earthrise" photograph that so dramatically captured our own planet rising above the lunar landscape. Bill Anders had a line that perfectly captured the moment, "We came to explore the moon and what we discovered was the Earth."

The impact of the photograph was quite visceral, changing forever our view of Earth from the perspective of the many lands we each occupy, to a more holistic view of the planet as a single system. Not surprisingly, the environmental movement adopted the image as a tool to remind us that we are all in this together.

These *Outlook* columns are all of a type. Each one takes a look at some singular aspect of the world around us, and then applies the lesson back to our business here at Glenair. Read individually, the articles are like the many countries, organizations, businesses, and neighborhoods we each occupy on earth. But read as a series, they become a holistic view of the system of values and practices we follow here at Glenair. The perspective I hope to share with you all today is that only by viewing and treating the important realms of our lives as integrated systems—rather than as random assortments of tasks and duties—can we ever hope to achieve balance, happiness and success.

No matter what our individual roles are, we all need to be reminded now and then to step back, to get a little distance, to consider our activities in the context of the larger system. Like the Apollo 8 astronauts, who paused in their laser-focused examination of the moon's surface to look up and witness, for the first time in human history, our blue-green planet rising above the horizon.

There's an old saying that "distance gives perspective." It seems to me that this is a powerfully important thing to practice in life—whether you are orbiting the moon, or doing your job down here on Earth.

Chris Toomey

QwikConnect

GLENAIR • Volume 25 • Number 1

Publisher
Christopher J. Toomey

Managing Editor
Marcus Kaufman

Editor/Art Director
Mike Borgsdorf

Graphic Designer
George Ramirez

Technical Consultant
Jim Donaldson

Issue Contributors
Martin Eichelberger
Shawn Grady
Guido Hunziker
Brian Kaufman
Nate Kaufman
Ron Logan
Torsten Möllers
Ali Yassine

Distribution
Terry White

To subscribe or unsubscribe, please contact Terry White: twhite@glenair.com

QwikConnect is published quarterly by Glenair, Inc. and printed in the U.S.A.

A complete archive of past issues of QwikConnect is available on the Internet at www.glenair.com/qwikconnect

GLENAIR, INC.
1211 AIR WAY
GLENDALE, CA 91201-2497
TEL: 818-247-6000
FAX: 818-500-9912
E-MAIL: sales@glenair.com
www.glenair.com