

Reference Applications

Brief history of Glenair space-grade design-ins



**Atmospheric Infrared
Sounder (AIRS)**

Glenair-built cables provide signal and power interconnection on a broad range of space applications including The **Atmospheric Infrared Sounder (AIRS)** instrument aboard the Aqua Earth-observing satellite, JPL Mars Probes, the Space Shuttle, and the AIRS satellite. Several notable space applications include:

The **Gravity Probe**, confirmed two key predictions of Einstein's general theory of relativity in 2011 by monitoring the orientations of ultra-sensitive gyroscopes relative to a distant guide star. Glenair-built cables are on board.



Gravity Probe

Titan II space-launch vehicles, with Glenair-made interconnect harnesses, propelled all twelve manned Gemini capsules.

Hermetic connectors are ideal for high-pressure/low-leakage applications in air, sea and space environments. Made of stainless steel (CRES) with glass insulators fused to the connector shell, and suitable contacts meeting a leak rate of 1×10^{-6} cubic centimeters of Helium per second, these mounted receptacle connectors and bulkhead feed thru prevent gases from travelling through apertures or penetrations created for the routing of interconnect cabling. Glenair hermetics have protected a range of space programs including:

The **X-38** program implemented to design and build a spacecraft capable of flying itself and the Space Station crew back to Earth in an orbital emergency.

Pegasus rockets, the winged space booster vehicles used in an expendable launch system developed by private industry.



The X-38

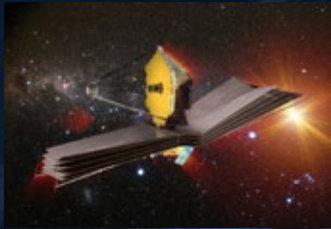
MetOp-A, Europe's polar-orbiting satellite dedicated to operational meteorology.

A well designed interconnect system will include a complement of grounding and shielding technologies to insure EMC. **EMI filter connectors** are an effective method to achieve electro-magnetic compatibility. Glenair is extremely well versed in supplying filter connector products optimized for use in space-grade applications, providing products compliant to EEE-INST-002, Table 2G, the recognized standard for space grade filters. Glenair MIL-DTL-38999, Series 80 Mighty Mouse, Series 28 HiPer-D, and Series 79 Micro-Crimp filter connectors are currently qualified and used by Ball Aerospace, Boeing Space, NASA/JPL, Orbital Sciences, Sierra Nevada Corp., and others. Notable Glenair Filtered connector space applications include:



MetOp-A

Skynet, for the United Kingdom Ministry of Defence, to provide strategic communication services to the three branches of the British Armed Forces and to NATO forces engaged on coalition tasks.



JWST

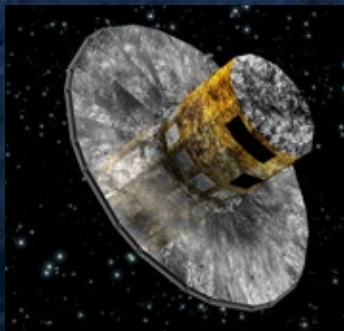
The **James Webb Space Telescope (JWST)** is a large, infrared-optimized space telescope. JWST is designed to find the first galaxies that formed in the early Universe, connecting the Big Bang to our own Milky Way Galaxy.

Micro-D connectors, including environmental, hermetics, filters, and flex assemblies are commonly used in space applications for their high-performance and small size. The precision-

machined shell of the Micro-D, with its robust mating retention forces, makes for an ideal connector for rocket and space vehicle applications that are subject to high levels of vibration and shock. The Micro-D is easily customized with package and mounting modification to fit virtually any integration challenge. A short list of Glenair Micro-D space applications would include the James Webb Space Telescope, SkyNet 5 military satellite, ALMA space telescope, JPL Mars Probe, Mars Curiosity Rover, AIRS satellite, and others. Several notable space applications that use Glenair Micro-D connectors include:

The **Herschel Space Observatory**, from the European Space Agency, made several scientific discoveries in its operational phase from 2009 – 2013, including a previously unknown and unexpected step in the star formation process, and the presence of molecular oxygen in space.

The European Space Agency also developed and built the **Gaia** satellite. Launched in 2013, its mission is to construct the largest and most precise map to date of the Milky Way. Its 2016 data release included positions and magnitudes for 1.1 billion stars



Gaia satellite

Cassini-Huygens was a joint NASA/ESA/ASI robotic spacecraft mission studying Saturn and its moons. Cassini executed several risky passes through Saturn's inner rings before completing its mission by burning up in atmospheric entry—but the data it returned will be analyzed for years to come.

CrIS is an advanced atmospheric sounding instrument aboard the United States Suomi National Polar Partnership (NPP) Polar-orbiting Operational Environmental Satellite. It produces high-resolution pressure, temperature, and moisture profiles from space, enabling more accurate predictions of severe weather events.

Glenair M32139 Class S Nanominiature connectors are DSCC approved for space programs. Glenair Nanominiature connectors, cable assemblies and flex circuit assemblies are currently in use on the several space-based telescopes,



Skynet



Herschel Space Observatory



Cassini-Huygens



CrIS NPOESS Satellite

including the Large Synoptic Survey Telescope (LSST), James Webb Space Telescope, and others.

The *Series 79* connector is a Glenair original design. It features crimp, rear-release size #23 contacts on 0.075" spacing, as well as size #12 and #16 power and coaxial crimp contacts available in 29 insert arrangements for data and power transmission. The Series 79 Micro-Crimp is ideally suited for blind-mate rack and panel and/or module-to-chassis applications; and is currently qualified for use by Orion, Ball Aerospace, Honeywell Space, and LMCO Denver.

Glenair *Series 80 Mighty Mouse* connector and cable assemblies were developed as a smaller and lighter alternative to MIL-DTL-38999, offering virtually equal performance with up to 71% (weight) and 52% (size) savings for similar contact layouts. Mighty Mouse is well established in hundreds of safety-critical military, medical, industrial and geo-physical and space applications. Some space applications for this reduced form factor connector include:

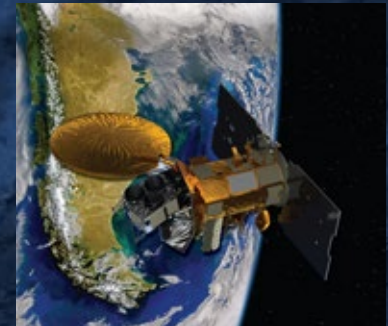
NASA's Mars Exploration Rover (MER) Mission, an ongoing robotic mission to explore the Martian surface and geology. The Opportunity rover is continuing her winter exploration of "Perseverance Valley" on the west rim of Endeavour Crater.



A Mars Curiosity Rover "selfie"

The Mars Science Laboratory Curiosity landed in Mars' Gale Crater in 2012. This rover is over five times as heavy and carries over ten times the weight in scientific instruments as previous rovers. Within weeks, Curiosity discovered an ancient streambed where water once flowed, and evidence of a lake that could have supported microbial life in the distant past. Curiosity's original 2-year mission has been extended indefinitely, and it's still returning valuable data more than 5 years after landing.

Aquarius was a satellite mission to measure global Sea Surface Salinity. It provided the global view of salinity variability needed for climate studies.



Aquarius Satellite

Glenair *Sav-Con® Connector Savers* protect deliverable connectors subject to repeated mating and unmating cycles, especially from repetitive qualification test cycles. Sav-Con® Connector Savers prevent costly repair or replacement of cable plugs and receptacle connectors by absorbing connect and disconnect abuse and by reducing mating cycles during testing to the absolute minimum.

A virtual "Who's Who" of space programs use Glenair Sav-Cons including Boeing Satellite Systems, the Delta IV launch vehicle, Voyager, Galileo, Magellan, Cassini, and others—both during fabrication testing and in operation.

One of the most dramatic applications of our Sav-Con connectors is on the Space Shuttle Orbiter where they provided protection for the umbilical connectors from liftoff to touchdown on every mission.

For many space applications, the cable shield is the most important element in controlling EMI and radiation damage. Unfortunately, metal shielding—especially when applied in multiple layers—can be extremely



A NASA LEO (Low Earth Orbit) Satellite

heavy. *AmberStrand* composite thermoplastic braid, and *ArmorLite* microfilament stainless steel braid provide robust EMI shielding at a fraction of the weight of conventional shielding. Glenair lightweight braid technologies are currently qualified for use by EADS Astrium, Honeywell Space, Orbital Sciences, and Ball Aerospace. These unique products notably served on:

The *Cassini-Huygens* Program, an international science mission to the Saturnian system.



Ariane 5

Mars Pathfinder, which delivered an instrumented lander and a free-ranging robotic rover to the surface of the red planet.

The Glenair *Qwik-Clamp backshell* is used on the *International Space Station*. This gold plated part is extremely resistant to space corrosion and radiation and is designed with all smooth surfaces to eliminate potential damage to space suits.

Other circular backshell and connector accessory space applications include:

The European Space Agency's *Ariane 5*, which launches satellites and other craft into geostationary transfer orbit (GTO), medium and low Earth orbits, Sun-synchronous orbits (SSO) and Earth-escape trajectories

SEA Launch was a spacecraft launch service using a mobile sea platform for equatorial launches of commercial payloads.

As with circular backshells and accessories, Glenair has the rectangular interconnect world well covered. We supply everything from miniaturized backshells for Micro-D connectors to larger rack-and-panel connector accessories. Glenair rectangular accessories are used on dozens of space programs including the *International Space Station*, *MetOps*, *Herschel Space Observatory*, *James Webb telescope*, and others.

Recent / Notable Space-Grade Application Wins for Glenair

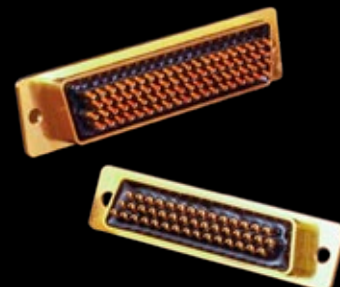
Glenair is the exclusive interconnect connector and cable supplier to the *Sierra Nevada Dream Chaser* reusable crewed suborbital and orbital space plane. The *Dream Chaser* electrical wire interconnect system incorporates Glenair Micro-D subminiature connectors, EMI filter connectors, flex circuitry, lightweight microfilament braid, metal and composite backshells, and other technologies.

The Glenair Series 28 HiPer-D High-Performance MIL-24308 Intermateable

Glenair's qualified MIL-DTL-24308 Class K space-grade hermetic, and our recently-introduced Series 28 HiPer-D connector series have become the go-to standard for mission-critical space applications and are now qualified for use by *Ball Aerospace*, *LMCO Denver*, *Orbital Sciences*, and others.



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



Gold-plated space-grade Series 28 HiPer-D connectors

INTERCONNECT SHOWCASE