QwikConnect

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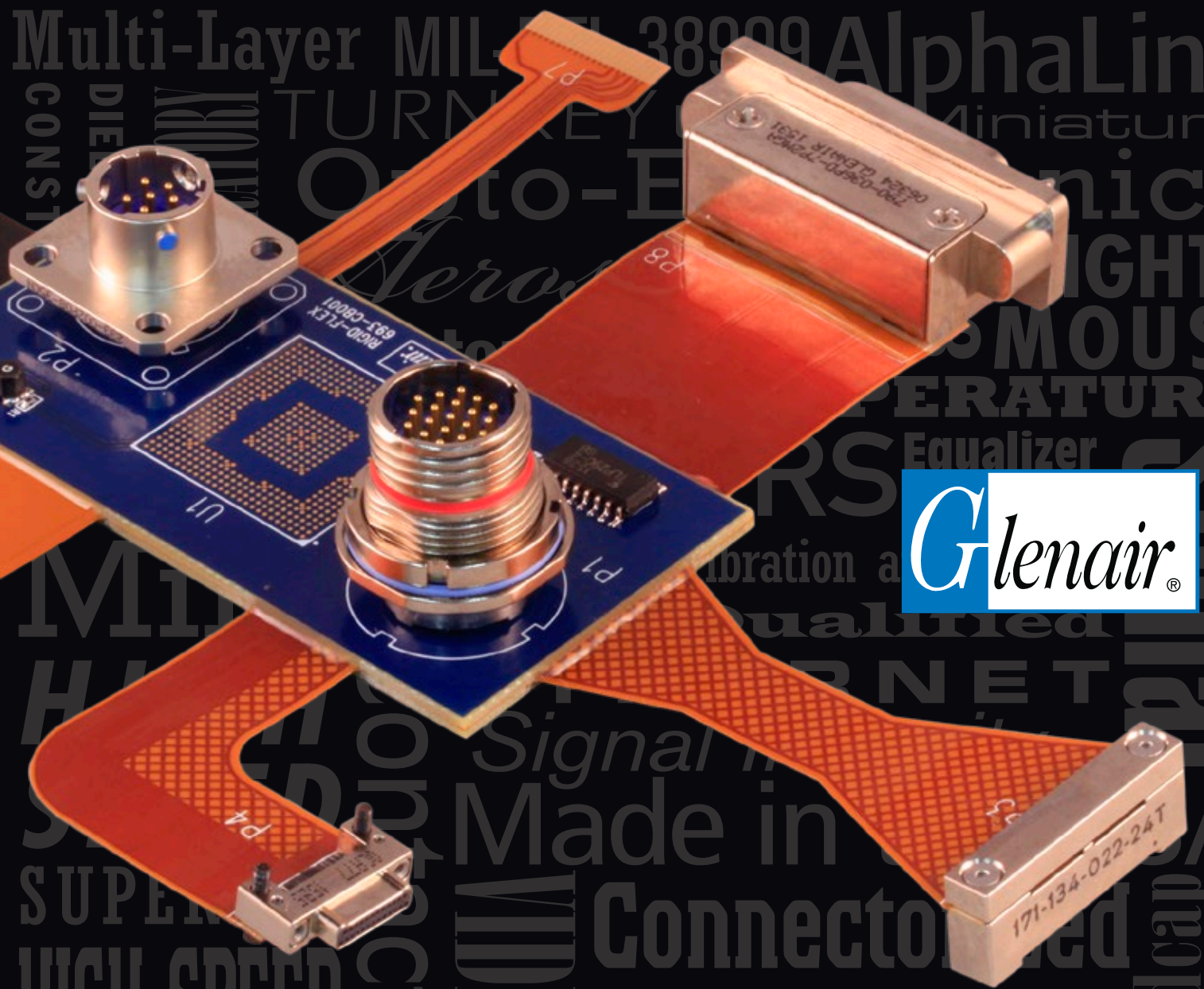


Optimizing Flex for High Speed

The design of flex and rigid-flex interconnect assemblies is an exacting science, made more so when management of high-speed digital signals is an added requirement. This is because material choices that support high-speed signal integrity and impedance matching can significantly affect the flexibility, weight, size and packaging of a flex circuit assembly.

Flex and rigid-flex design is successfully accomplished by following a recipe of best practices—executed via design rules in the layout software and other tools—to balance and manage the many trade-offs between conflicting layout and functional goals. To follow the recipe, successful flex and rigid-flex PCB designers depend on a clear understanding of the intended application, particularly how rigid and flexible sections will be packaged within the enclosure, or stressed during use. This initial step in the design process will largely determine the tradeoffs between signal integrity and mechanical properties.

Dynamic Flex Versus Flex-to-Install

One of the first questions asked is whether the flex circuit assembly must bend or fold dynamically as a normal requirement of daily use—for example in an actuated robotic arm or in the folding wings of a man-portable drone. In these application examples, the designer would naturally prioritize materials and designs that optimize durability and integrity of the flexible circuits over other properties—even high-speed signal integrity. Obviously signal-management cannot be altogether ignored, but the question is moot if the flex circuit fails to meet flex cycle durability requirements.

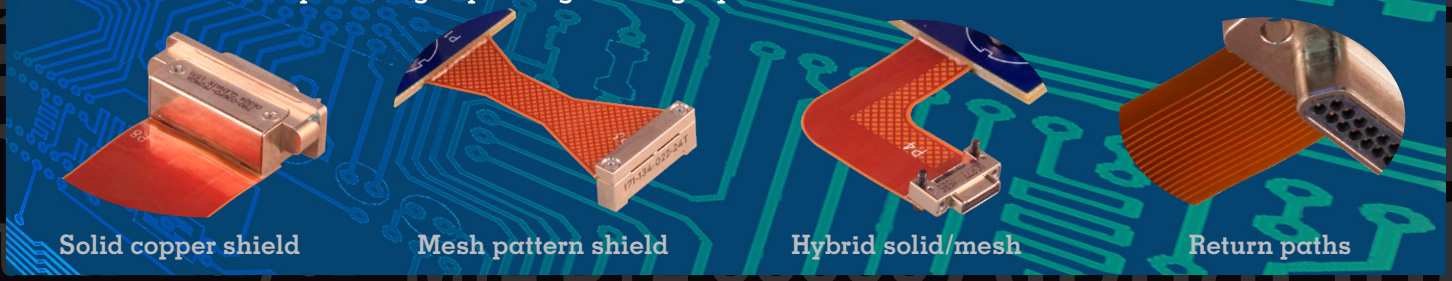
At the opposite end of the spectrum, applications with little or no budget for data loss will require the designer to maximize signal integrity and impedance control over other parameters. In such situations, the choice is often made to route high-speed protocol signals over a solid copper ground plane. While unbroken ground planes are not particularly flexible, they do maximize shielding and control of the signal circuit. The challenge with this approach is that copper, being a relatively hard material, will eventually harden and crack as a result of repetitive stress cycles. Rolled-annealed copper may be an option for some applications where signal integrity warrants the additional cost and complexity. The improved ductility and larger copper grains make the copper less likely to crack due to bending.

While dynamic flex circuit assemblies are subject to repetitive bend forces as a condition of normal use, as a practical matter, most flexible circuitry is only flexed and stressed during installation or occasional service. In addition, virtually all mission-critical flex assemblies in our application space typically support modern datalink protocols such as Ethernet, USB, HDMI and so on. As a result, most of the application examples featured in this special issue of *QwikConnect* are designed to:

Robotic arm: *Classic example of a highly dynamic application in which actuated wire and flex interconnect assemblies are qualified to deliver millions of flex cycles without electrical or mechanical failures*

Ground Planes and Shields

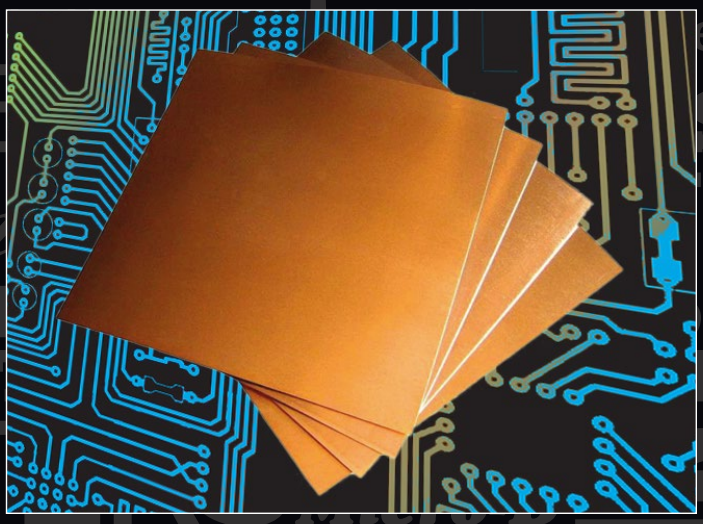
Solid copper ground planes, mesh pattern ground planes, hybrid configurations, return path layouts, and other approaches to managing EMI emissions and signal line impedance are critical aspects of flex circuit design. Effective use of ground / shield planes combined with appropriate connector interfaces and matched-impedance flex circuits deliver optimal high-speed signal integrity.



Solid copper shield | Mesh pattern shield | Hybrid solid/mesh | Return paths

1. take advantage of the benefits of flex and rigid-flex assemblies (principally size/weight reduction and performance reliability),
2. provide adequate flexibility for the install process, and
3. manage signal integrity within the data loss budget of the application and the electrical requirements of the datalink protocol.

Obviously, "flex-to-install" applications can utilize additional ground planes for improved signal integrity compared to dynamic flex applications. Material choices such as the hatched polygon shielding illustrated in the sidebar are ideal for designs which must affect this balance between signal integrity and a target flexural modulus. The relative drawback is reduced signal integrity as this design choice does not provide full EMI coverage and makes ground impedance matching more challenging. The addition of discrete solid copper return paths directly under high-speed traces can reduce this effect.



▲ A "flex-to-install" assembly *in which a flex circuit element is not subjected to daily dynamic stress*

Dielectric Constants

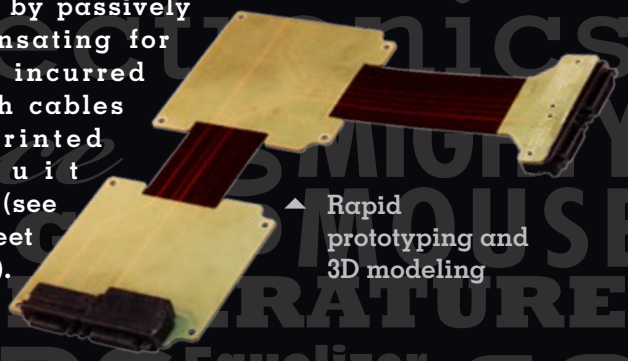
It is important to note that the polyimide materials used in flex and rigid-flex circuit assemblies perform inherently better at high frequencies than the standard FR4 board materials commonly used in rigid PCBs. FR4 is the grade designation assigned to glass-reinforced epoxy laminate sheets used in the fabrication of standard PCBs and in the reinforced portions of rigid-flex interconnect assemblies. FR4 is a composite material made of woven fiberglass cloth with a flame-resistant epoxy resin binder. The composite nature of this material can adversely affect dielectric properties, and in turn, the board's ability to carry high-speed digital signals.

By comparison, flex circuit dielectric materials are homogeneous (they do not contain glass fillers) and so deliver more consistent dielectric performance. For high-frequency RF and microwave applications, Glenair typically utilizes base material alternatives to FR4, such as Rogers 4000 (a hydrocarbon ceramic laminate with superior high-frequency, low-loss performance).

Attenuation

Attenuation is not unique to high-speed protocol applications. In fact, attenuation theory was first developed in the 1800s in the telegraph industry to model the performance of analog transmissions over long-distance, cross-country wires. Simply put, the longer the wire, the less signal makes it to the far end. High-speed signal transmission on boards is very lossy compared to the performance of cables. Distances as short as a few inches can be problematic. In addition to attenuation over distance, dielectric discontinuities in PC board or flex circuit traces can also cause unwanted back-reflection of signals. Even seemingly minor changes in material properties, trace width or shape, inexact placement of vias, proximity to noisy power traces or variable thickness in dielectric materials can result in signal integrity problems.

A PC board or flex circuit trace that is not terminated in its characteristic impedance to the board or I/O connector can also impact signal integrity by reflecting signals at the termination. For this reason, Glenair flex assembly designers pay considerable time and attention to flex-to-board terminations and flex-to-I/O connector terminations to take advantage of interconnect solutions that best match the characteristic impedance properties of the flex media. Several Glenair interconnect series, notably El Ochito, have optimized contact-to-contact spacing and length to ensure characteristic impedance is maintained from wire-to-I/O-to-flex-to-board. A new Glenair Micro-D sized solution, The Equalizer, takes the assignment one step further by passively compensating for losses incurred through cables and printed circuit boards (see datasheet page 21).



▲ Rapid prototyping and 3D modeling

Mechanical / Electrical Modeling for High-Speed

Once board materials, I/O connectors and preferred flex-to-board termination methods have been chosen, the layout and mechanical design schematic of the assembly starts to take shape. It is at this stage that the number of layers in the flex assembly can be determined and decisions made

on routing to meet packaging requirements. Even at this preliminary stage—which includes the fabrication of "paper doll" or other 3D model types for fit check and ease-of-installation—best practices and ECAD design rules for optimizing the assembly for high-speed or high-frequency come into play. For example, we mentioned earlier that ground planes of rolled-annealed copper may be employed in applications that require both a high-flexural modulus and high signal integrity. In this case designers must be careful to ensure the material is modeled axially in line with desired flex direction as rolled-annealed copper is only truly flexible along the machine-line axis in which it was rolled. By the way, this design parameter can be important even in non-dynamic flex applications, for example if the assembly will be subjected to severe levels of vibration and shock.

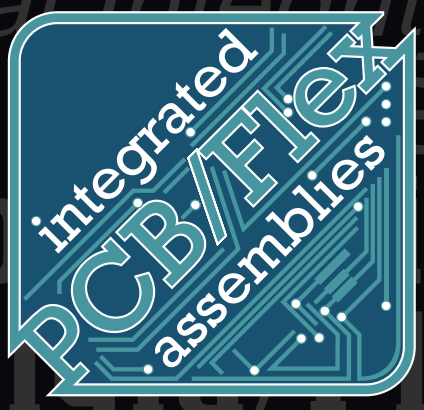
From missile applications to small form-factor radar, Glenair flex circuit assemblies are optimized for high-speed data transmission

In practical terms, designing flex for high-speed entails following established design rules that result in layer types with proven mechanical/electrical performance. This is the opportunity to reduce crosstalk, by shielding traces with copper planes, optimizing the spacing between traces, routing traces orthogonally to each other, or using differential pairs. These layer types include:

- Co-Planar Stripline: in this format, ground and power traces are carried on a single layer of the flex, but in an alternating pattern that isolates noise producing traces one from the other.
- Microstrip Circuits: Two-layer constructions with one all-metal layer assigned as ground. Applicable to 50Ω characteristic impedance applications.
- Stripline Circuits: Well suited for 100Ω and differential pair applications. Stripline circuits sandwich transmission traces between two ground planes delivering outstanding signal integrity—albeit with some loss of flexibility.
- 360° Shielded Stripline: Signal line is surrounded on four sides by ground replicating the impedance characteristics of coaxial cable. Used to combat crosstalk and deliver maximum signal integrity, again with appreciable loss of flexibility in the assembly.

In addition to specifying the layer type, designers will input chosen material types including thickness (the thinner the dielectric the more capacitance a signal line will have), and where appropriate, the dielectric constant of the material. Armed with these key variables, ECAD tools can perform impedance calculations to ensure the integrity of high-speed signals. Establishing the dielectric constant of insulating materials is a critical step as flex circuit traces can readily couple to another trace causing interference. This danger increases as signal rise and fall times get shorter, and as the traces get longer. As signal speed depends upon the dielectric constant of the materials insulating the line, this value must be determined to effect digital circuit integrity.

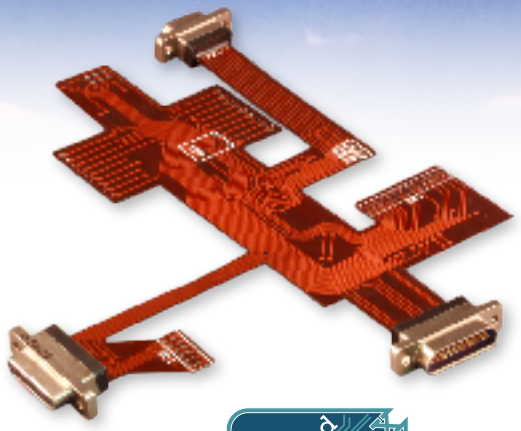
As previously noted, all of this work depends on the quality of the analysis done up-front, especially an understanding for the end-use application of the flex. Glenair's Turnkey Interconnect Flex Assembly group has all the experience and expertise required for even the most exotic high-speed datalink applications.



TURNKEY

PCB/Flex Circuit Assemblies

Full-service: from concept and design through fabrication, assembly and test



integrated PCB/Flex assemblies

PCB/flex circuit assemblies solve a myriad of problems for the electrical engineer. PCB/flex circuits offer unsurpassed size and weight reduction compared to cable bundles, especially in tight spaces with multi-branch routing. Flex circuitry offers outstanding mechanical performance, and is able to withstand extreme vibration environments and extended duty through thousands of flexing cycles. Replacing complicated wire bundle assemblies with high-density flex assures faster, error-free LRU assembly.

Glenair offers full-service, turnkey PCB/flex circuit assembly in our vertically-integrated design and manufacturing lab—from concept and Gerber design layout, through PCB/flex fabrication, termination to any of our I/O, board level or mezzanine connectors, and rigorous system validation testing and inspection. Ask us about our quick-turn 3D prototyping services.

Glenair®
ISO 9001 Certified
AS9100 Certified
Worldwide Quality System

ADVANTAGES OF FLEX CIRCUITRY

- **Optimal size and weight reduction**
- **Repeatable, reliable installation virtually eliminates wiring errors**
- **Withstands high levels of shock and vibration**
- **Convenient packaging and integration**
- **Up to 1 million flex and duty cycles**

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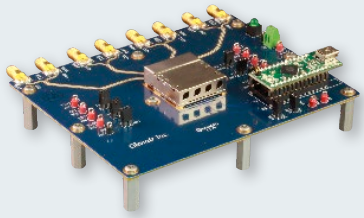
PCB/Flex Circuit Assemblies

Manufacturing • Product array

CONNECTORIZED FLEX ASSEMBLIES

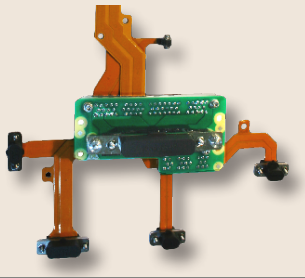
- Point-to-point or multibranch connectorized jumpers
- Flexible, repeatable routing for complex 3-dimensional installations
- Save size, weight, and improve density compared to wire bundles
- Broadest range of high-performance I/O and board connectors
- Optimized reliability: high-speed, high temp, high shock and vibe

RIGID BOARD ASSEMBLIES



- Rigid substrate assemblies for rugged durability and performance
- Hard-mount points for connectors and surface-mount components
- Ideally suited for double-sided component mounting
- Superior performance in high shock and vibe applications

RIGID FLEX ASSEMBLIES



- "Best of both worlds" combines durable rigid-board architecture with flex circuitry for double-sided component mounting and easy/flexible circuit routing
- 3-D vibration-resistant flex routing advantage plus hard mount points and stiffeners as required
- Integration of active componentry with flex circuitry

GLENAIR INTEGRATED FLEX ASSEMBLIES: A UNIQUE VALUE PROPOSITION

Connector Manufacturing

Glenair is a vertically-integrated operation, with over 1 million square feet of engineering and manufacturing space in the United States, Mansfield U.K., and Bologna Italy. Only Glenair, amongst the many suppliers of Flex and Rigid Flex assemblies, offers such a broad range of high-reliability printed circuit board connectors of our own design and manufacture—including thousands of Mil-qualified and commercial I/O and PCB termination solutions. Glenair is IPC 610, ISO 9001 and AS9100 certified.

Board Manufacturing

Glenair offers IPC Class III manufacturing, up to 8+ layers, multiple panel sizes and panel thicknesses up to .5 inch. A broad variety of materials are available for PCB/Flex fabrication, including Polyimide, FR-4, Rogers 4003, and Isola. Available surface finishes include ENIG, HASL, Ni/Au and more.

Turnkey Validation Testing and Production Delivery

Glenair's in-house capability can meet every requirement, from a single piece to large production orders. All assemblies are terminated, tested, and packaged in our Glenair Quality System controlled production lab.

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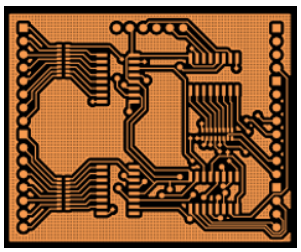
PCB/Flex Circuit Assemblies

Flex and rigid board specification standards



SPECIFICATION STANDARDS

The following tables describe, in brief, Glenair flex and rigid flex manufacturing formats and specifications. Glenair recommends commercial customers understand and adhere to IPC-6012/6013 specification standards which are fully supported by Glenair. Military customers may alternatively cite specifications IAW MIL-PRF-31032.

* Information below is based on the most common materials and physical property requirements. Please consult the factory for alternatives

Flex Assemblies

Manufacturing Formats	Gerber • DXF • Altium
Layer Count	Max typ. up to 8
Termination	Thru hole • Reverse bare • Floating fingers / Sculpted circuits • ZIF Termination
Conductor Width/Space	Lines: .004" • Spacing: .004"
Bend Radius (military)	Single Metal Layer: 4–6X overall flex thickness• Double Metal Layers: 6–10X overall flex thickness • Multi Layer Metal: 12–15X overall flex thickness
Materials / Tg	Substrate: DuPont™ Kapton® polyimide flex adhesive and adhesiveless -60°C to 125°C Cover layer: DuPont™ Kapton® Stiffener: FR4 or DuPont™ Kapton® (metal stiffeners available upon request) Conductor: Copper, Aluminum, SS, Constantan High-temperature materials available
Surface Finish	ENIG • HASL • Immersion Tin and Silver
Specs and Quality Management	IPC-6013 Class I, II, III, types 1-3 • ISO 9001, AS 9100

Rigid Flex Assemblies

Manufacturing Formats	Gerber • DXF • Altium
Max Panel Thickness	Range of thicknesses from .010" to as thick as .250"
Layer Count	20 +
Via Technology	Blind, buried • Thru hole • Filled (conductive and non-conductive)
Conductor Width/Space	Lines: .004" • Spacing: .004"
Materials / Tg	Substrate: FR4: 180° C
Surface Finish	ENIG • HASL • Immersion Tin and Silver
Specs and Quality Management	IPC-6013 Class I, II, III, type 4 • ISO 9001, AS 9100

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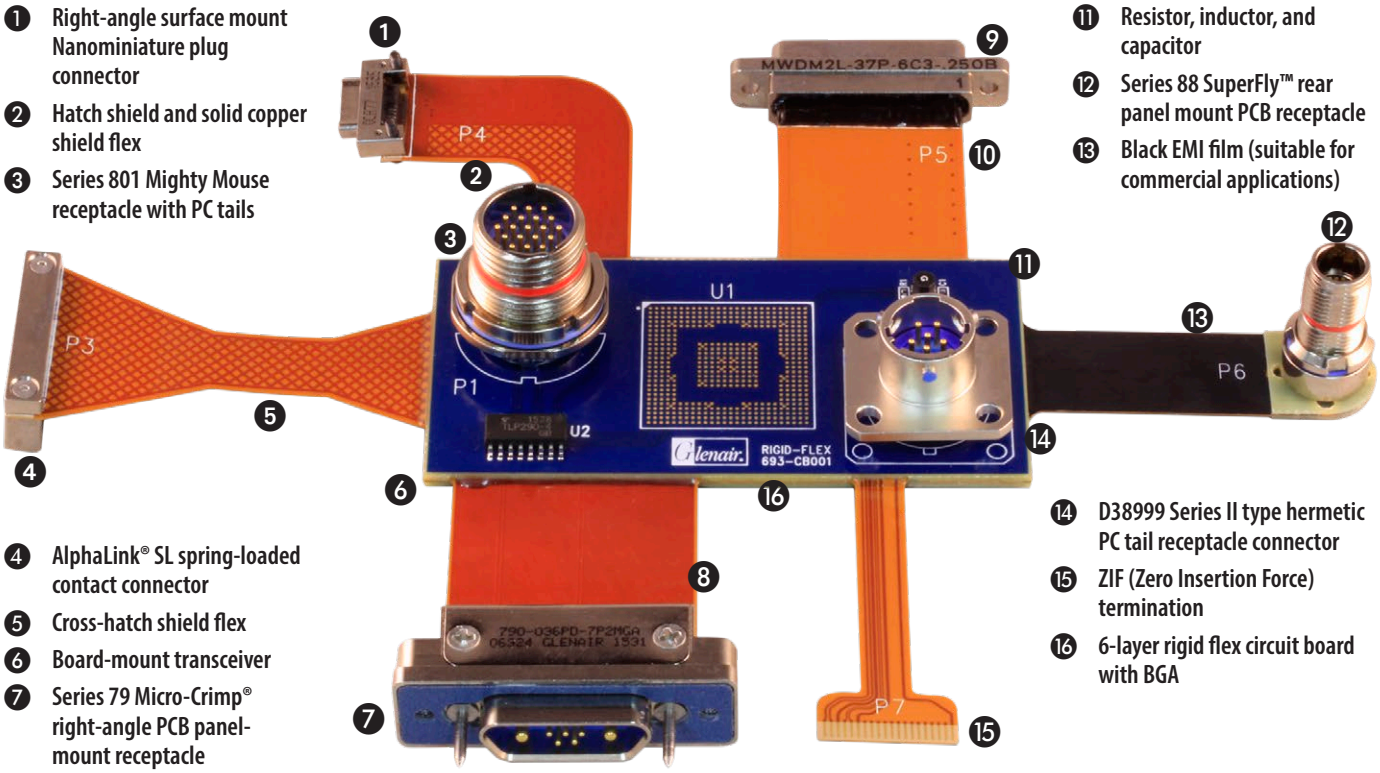
PCB/Flex Circuit Assemblies

Design options and rapid prototyping

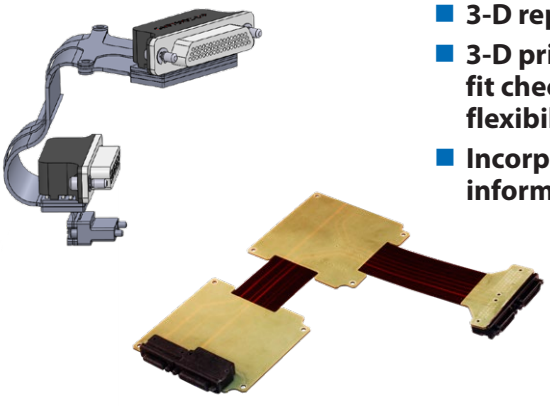
STANDARD DESIGN OPTIONS FOR INTEGRATED (CONNECTORIZED) FLEX/RIGID FLEX ASSEMBLIES

Properly designed flex and rigid flex assemblies offer significant space and weight savings compared to wire harnesses. Many design options are available, including integrated stiffeners, shielding, factory forming, selective bonding, termination, layer count and so on.



1. Right-angle surface mount Nanominiature plug connector
2. Hatch shield and solid copper shield flex
3. Series 801 Mighty Mouse receptacle with PC tails
4. AlphaLink® SL spring-loaded contact connector
5. Cross-hatch shield flex
6. Board-mount transceiver
7. Series 79 Micro-Crimp® right-angle PCB panel-mount receptacle
8. Solid copper shield flex
9. Micro-D 37-pin connector
10. Silver paste shield flex
11. Resistor, inductor, and capacitor
12. Series 88 SuperFly™ rear panel mount PCB receptacle
13. Black EMI film (suitable for commercial applications)
14. D38999 Series II type hermetic PC tail receptacle connector
15. ZIF (Zero Insertion Force) termination
16. 6-layer rigid flex circuit board with BGA

RAPID PROTOTYPING



- **3-D representation of flex assemblies using SolidWorks**
- **3-D printed "Paper doll" outline mockups for physical assembly fit checks with copper clad DuPont™ Kapton® to simulate actual flexibility**
- **Incorporation of customer-supplied wiring diagram and chassis information in laser-cut mechanical samples**

Example solidworks and 3-D paper doll prototype mockups produced by Glenair's Integrated Flex Assembly production laboratory—typical turnaround 2–3 days upon receipt of request

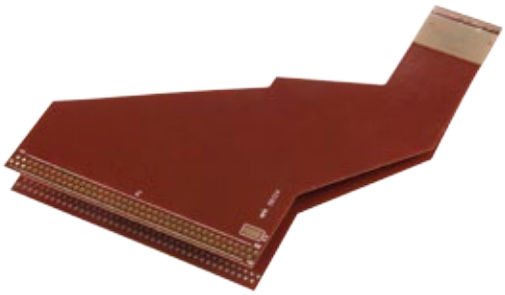
Dimensions in Inches (millimeters) are subject to change without notice. Rev. 11.29.17

RUGGEDIZED · HARSH-ENVIRONMENT

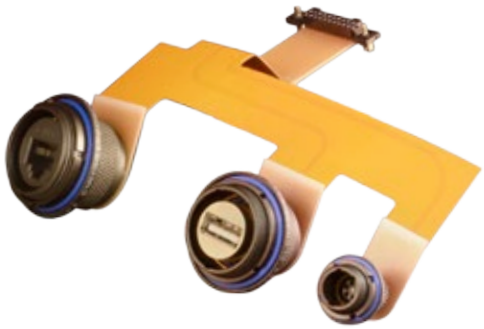
Application / Design Options

Packaging for optimal form, fit, and function

FLEX AND RIGID FLEX DESIGN OPTIONS



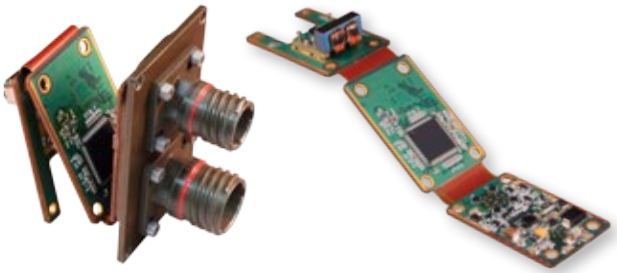
Selective bonding of discrete layers of flex circuitry



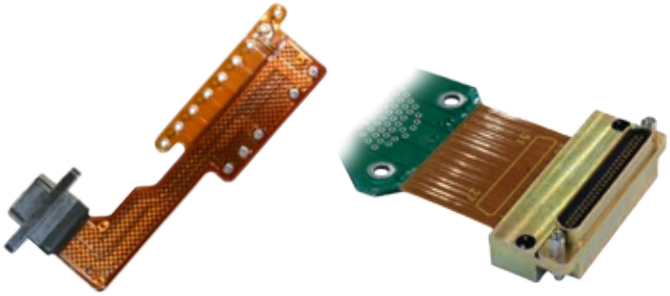
Stiffeners incorporated into flex: a practical approach for adding discrete mount points or component integration

Factory forming facilitates assembly and helps the flex circuit adhere tightly to available space and routing

EMI/RFI Shielding in flex circuitry is accomplished with solid or patterned shield planes and/or with shielded I/O interconnects

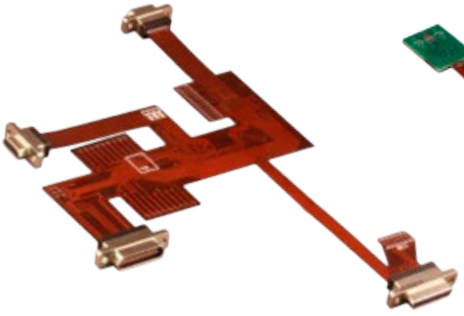


Hybrid flex, rigid flex, and embedded PCB technology facilitates electronic component size and weight reduction, and double-sided mounting of components

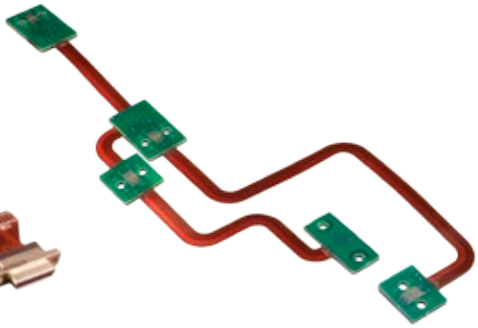


Flex and rigid flex combination assemblies provide hard mounting points and dynamic flexing and routing

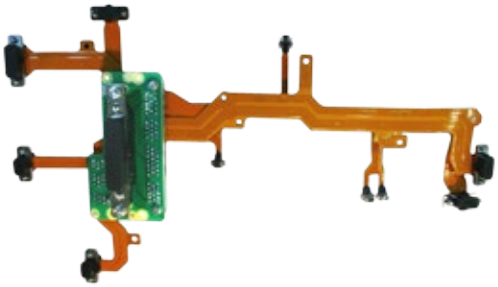
MULTIBRANCH FLEX AND RIGID FLEX CONNECTORIZED ASSEMBLIES



Micro-D subminiature multibranch flex assembly—a Glenair specialty.



Multibranch RJ45 / Ethernet / USB Flex assembly

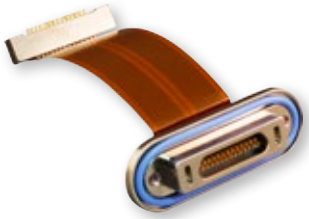


High density .025" contact center nanominiature multibranch flex assembly

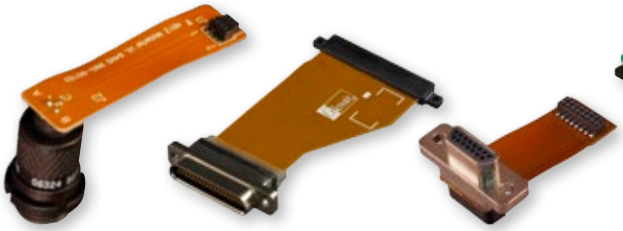
Application / Design Options

Packaging for optimal form, fit, and function

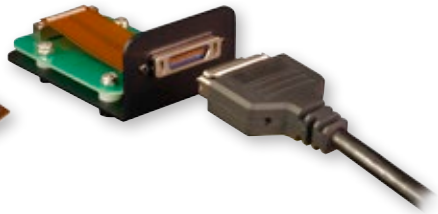
POINT-TO-POINT CONNECTORIZED FLEX AND RIGID FLEX JUMPER DESIGN OPTIONS



Environmentally sealed rectangular I/O interface flexi circuit

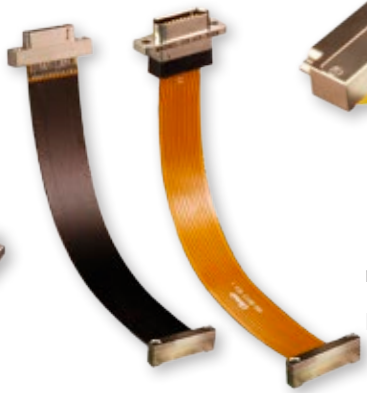


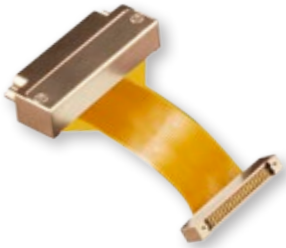
Military aerospace grade I/O connector to commercial-grade board level termination



Master-Latch quick disconnect Micro-D I/O flexi circuit

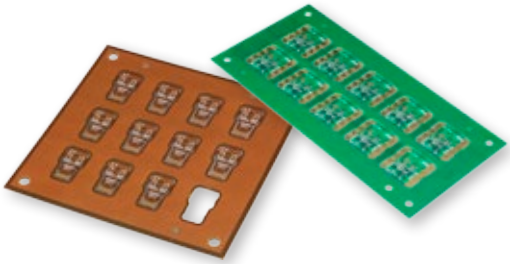
Military aerospace grade circular I/O connectors to matched impedance high-speed mil-aero board terminations





Military aerospace grade rectangular I/O connectors to matched impedance high-speed mil-aero board terminations

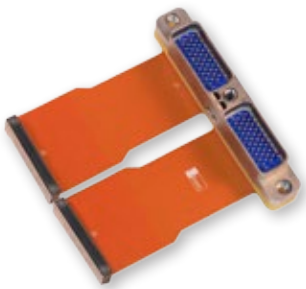
SPECIAL-PURPOSE FLEX AND RIGID-FLEX DESIGN OPTIONS



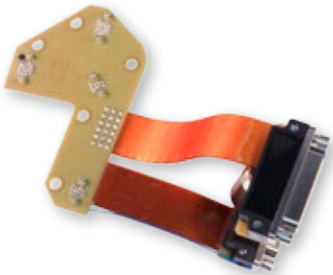
Production run of individual PCBs in panelized form

Space-grade Series 28 HiPer-D to Series 80 Mighty Mouse I/O jumper

High-shock matched-impedance Mighty Mouse assembly with flex circuit



Dual-gang series 20 Super-Twin™ I/O connector to AlphaLink SL PCB connector



Stacked Micro-D I/O connectors with flex jumper to rigid PCB assembly

EMI/RFI filtered power transmission flexi circuit assembly

TURNKEY

PCB/Flex Circuit Assemblies

Interconnect I/O and termination design guide

PARYLENE COMPATIBLE

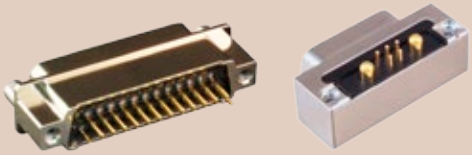
PARYLENE COMPATIBLE

First step in securing a price and delivery quote from Glenair is to communicate basic information regarding the flex assembly, including quantity requirements, number of layers, overall size, special features such as factory forming, stiffeners and so on. Accordingly, here is a five step flex design guide, beginning with I/O interconnect selection.

Note: all Glenair PCB I/O connectors are potted/sealed and certified parylene compatible.

STEP 1: SELECT FLEX/RIGID FLEX ASSEMBLY I/O CONNECTOR(S)

HiPer-D 24308 is a high-performance, precision machined, shielded alternative to commercial-grade D-subminiatures



HiPer-D 24308 straight and 90°

HiPer-D Combo straight and 90°

Series 79 Micro-Crimp is Glenair's high-density .075" contact center crimp-contact, mil-aero grade rectangular

straight and 90° PC tail panel plugs and receptacles

straight and 90° PC tail free-standing plugs and receptacles

Series MWDM (MIL-DTL-83513) high-density microminiature .050" contact spacing mil-aero grade Micro-D subs

condensed-pitch board terminations/ compact flange

surface mount

vertical and 90° thru-hole

Series 89 (MIL-DTL-32139) ultra high-density .025" contact spacing mil-aero grade nanominiature

single-row vertical PCB plugs / receptacles

dual-row right angle PCB plugs / receptacles

SuperNine "better than QPL" advanced performance D38999 Series III type connectors

SuperSeal field RJ45/USB

dual flange receptacle

High-speed El Ochito octaxial contacts

Ultra high density .075" contact center mil-aero solution for size and weight reduction

straight and 90° receptacles

Dual-flange PCB receptacles

SuperFly: the ultimate nanominiature tactical connector

straight and 90° QDC receptacles with mounting holes

straight and 90° jam nut threaded receptacles

Series 89 circular nanominiature connectors

Threaded straight and 90°

Breakaway straight and 90°

TURNKEY

PCB/Flex Circuit Assemblies

Interconnect I/O and termination design guide

The termination of flex and rigid flex assemblies to backplane and motherboard PCBs may be accomplished with a variety of interconnect technologies and flex design features. Glenair flex engineers have deep fluency in the maintenance and protection of signal continuity from the I/O interface to the board, including high-speed, matched impedance signal management, EMI/RFI shielding and so on.

STEP 2: DEFINE STYLE OF PCB / FLEX TERMINATIONS

Thru-hole

Surface mount

Pogo pin / spring-loaded contacts

Straddle mount

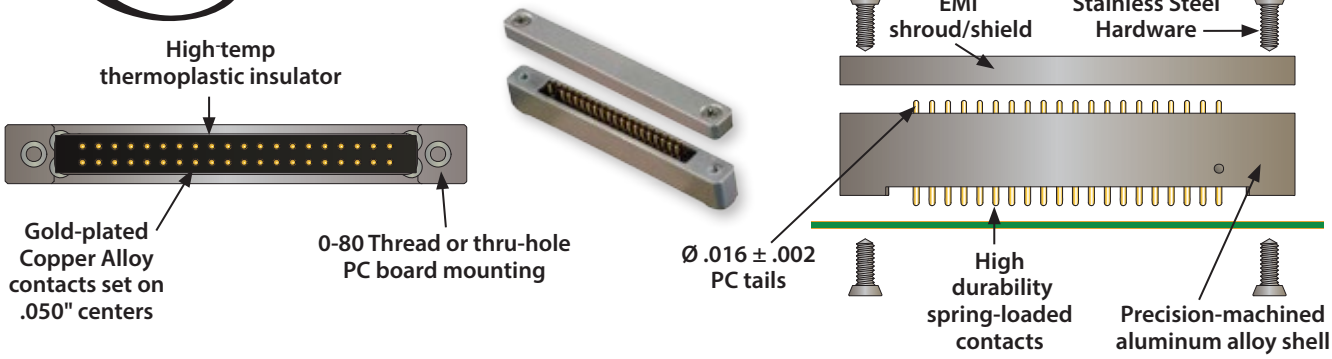
Nail head pins

Direct termination

Encapsulating pot

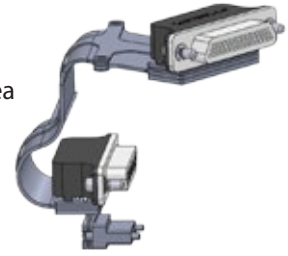
ZIF (zero insertion force

Alphalink® SL spring-loaded solderless contact board-level solutions for mission-critical applications



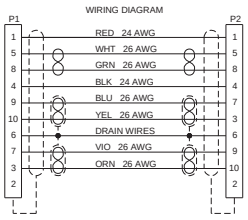
STEP 3: DEFINE MECHANICAL SCHEMATIC

- Customer-supplied 3-D file to determine "keep out areas"
- "Napkin sketch" with rough idea of routing
- Customer-supplied 2-D DXF



STEP 4: DEFINE ELECTRICALS

- To approximate layer count, we need a wiring diagram complete with signal types, currents, and shielding requirements
- Used to determine ROM pricing



STEP 5: DEFINE VALIDATION TEST REQUIREMENTS

Glenair offers complete circuit design and generation of PCB/flex fabrication data packages including component level documentation. Most flex customers specify a certain level of validation testing as a required part of the documentation package. Tests may include DWV/IR, continuity, impedance (eye pattern), and others.

Plane Spotting

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____

13. _____

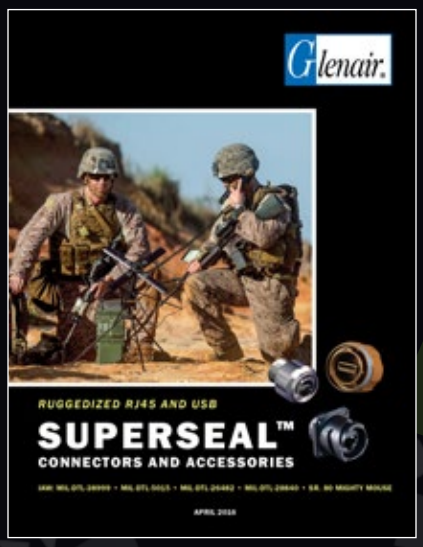
14. _____

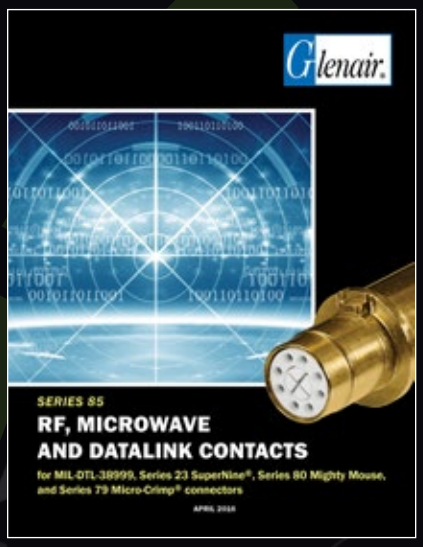
Answers published February 15th · www.glenair.com/qwikconnect

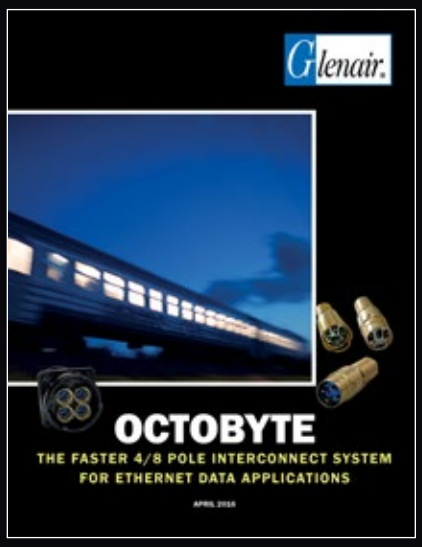
RUGGEDIZED

HIGH-SPEED DATALINK INTERCONNECTS

contacts · connectors · jumpers







SUPERSEAL™ IP67 OPEN-FACE RUGGEDIZED FIELD RJ45 SOLUTIONS

MIL-DTL-38999 Sr. III type SuperSeal™ RJ45

Series 80 Mighty Mouse SuperSeal™ RJ45

Series IPT 26482 type SuperSeal™ RJ45

Series ITS 5015 type SuperSeal™ RJ45

MIL-DTL-28840 type SuperSeal™ RJ45

SUPERSEAL™ IP67 OPEN-FACE RUGGEDIZED FIELD USB SOLUTIONS

MIL-DTL-38999 Sr. III type SuperSeal™ USB

Series 80 Mighty Mouse SuperSeal™ USB

Series IPT 26482 type SuperSeal™ USB

Series ITS 5015 type SuperSeal™ USB

MIL-DTL-28840 type SuperSeal™ USB

HIGH-SPEED / RF DATALINK CONTACTS

Size #8 differential twinax contacts

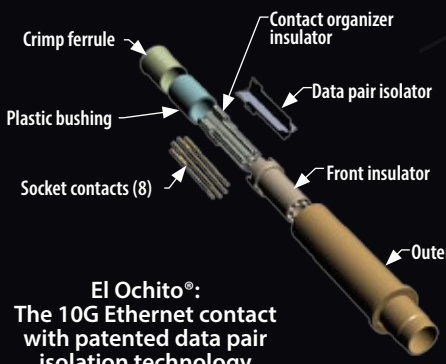
Size #12 ultra-twinax differential twinax contacts

Size #8 quadrax contacts

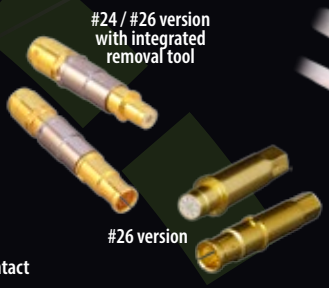
Size #8 spring-loaded BMB microwave contacts

Size #12 SMPM type spring-loaded coaxial

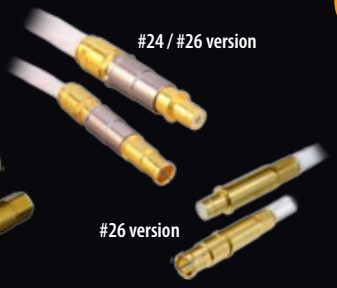
EL OCHITO® OCTAXIAL SIZE #8 CONTACTS FOR GIGABIT AND 10G ETHERNET



El Ochito®: The 10G Ethernet contact with patented data pair isolation technology



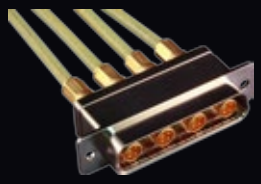
Discrete contacts for D38999 Series III type, Mighty Mouse, SuperNine®, and ARINC 600



Prewired contacts with Cat 6A aerospace #24 or #26 gage Ethernet cable

El Ochito® test adapters and test jumpers

GLENAIR CONNECTOR SERIES FOR EL OCHITO® AND OTHER HIGH-SPEED DATALINK CONTACTS



Series 28 HiPer-D® with Quadrax contacts

Series 23 SuperNine® with El Ochito PC tail contacts

Series 79 Micro-Crimp® with coax contacts

Series 80 Mighty Mouse with differential twinax

MWDM Micro-D with coax contacts

OCTOBYTE™ SERIES RUGGEDIZED ETHERNET CONNECTOR

Tested for compliance according to EN50173-1 standards for CAT5E and CAT7

Ethernet Cat7A contacts

Ethernet Cat5 contacts

Coax contacts

Ethernet MVB - WBT contacts

SPEED-MASTER™ 10G+ ETHERNET

Speed-Master™ modular 10G+ Ethernet technology (shown here in SuperNine®packaging) available now for 22D gage contacts and wires

Coming Soon SuperSeal™ RJ45 CAT 6a ETHERNET CONNECTORS

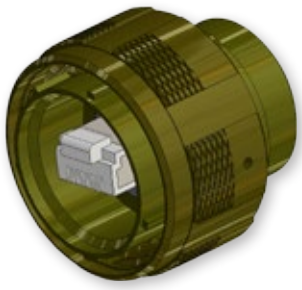
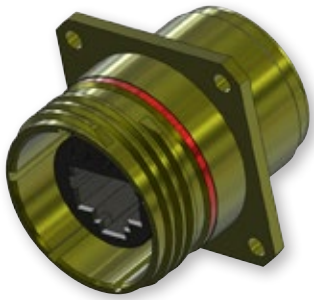
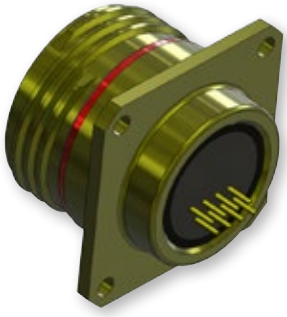
RJ45/USB SUPER SEAL™

RJ45 Cat 6a MIL-DTL-38999 Series III Type Wall-Mount Receptacle and Plug

High performance, proven reliability environmental connectors housing RJ45 interfaces for mission-critical data transfer applications

- **Superior sealing—IP67 minimum in unmated condition—for complete system protection against harsh elements**
- **Advanced thru-coupler grounding for superior electrostatic discharge and EMC**
- **Crimp, solder-cup, PC tail, quadrax, and compliant pin contact variations**
- **Scoop proof, self-locking, triple-start threaded coupling design of MIL-DTL-38999 Series III type connectors**
- **RJ45 cordsets with multiple length options available**
- **Integrated banding platform options for easy cable termination and EMI/RFI shielding**
- **Optional spring loaded protective covers for sand, dust, and mechanical protection of junction boxes and switches**
- **RJ45 plug and/or jack interfaces**
- **High Data Transfer Rates: 10GBase**

SuperSeal™ MIL-DTL-38999 Type RJ45 Connector Selection Guide

			
MIL-DTL-38999 Series III Type Plug Connectors with sealed RJ45 Plug (mated condition) Ethernet interfaces in a two piece coupler design. Easy field termination with Metal Gland backshell or shrink boot sealing options.	MIL-DTL-38999 Series III Type Receptacle Connectors with sealed RJ45 Jack-to-Jack Ethernet interfaces in a one piece coupler design. Metal Gland backshell and spring loaded protective covers available.	MIL-DTL-38999 Series III Type Receptacle Connectors with AS39029 crimp rear-release size #22D contacts	MIL-DTL-38999 Series III Type Receptacle Connectors with sealed RJ45 Jack interface and AS39029 rear-release crimp or solder cup #22D contacts. Size 22 Compliant Pin contacts, Quadrax Contacts or #22 PC Tail contacts also available.

COMING SOON

SuperSeal™ RJ45 Cat 6A Ethernet Connectors

Test data · product specifications

Test Description	SuperSeal MIL-DTL-38999 Series III RJ45 Performance Requirements/Specifications	Procedure Per MIL-DTL-38999 and TIA/EIS-568-B.2
Contact Resistance	Connecting hardware shall conform to A.2; a thru c of TIA/EIA-568-B.2 per IEC 60512-2, Test Method 2A, millivolt level method (shall not exceed 0.025 ohms and 0.050 ohms during subsequent tests	TIA/EIA-568-B.2, Section A.2 IAW IEC 60512-2, Test method 2A
Insulation Resistance	Per IEC 60512-2, Test 3a, Method C, test voltage 500 VDC (Insulation Resistance minimum of 100 Ohm)	IAW IEC 60512-2, Test Method 2A
Mating Durability	500 to 1000 cycles (finish dependent) with no mechanical damage. Contact Resistance requirement as described above shall be met at 0.050 ohms after 100, 200 and 250 cycles (and 500 per finish). This shall be performed before Thermal Shock and Humidity/ Temperature cycling test and the additional 250 cycles shall be testing after completion in the same manner.	4.5.8 IAW TIA/EIA-568-B.2
Contact Retention	Individual contacts capable of withstanding at least 10 pounds axial load applied uniformly 1 lb/sec	IAW EIA-364-29
Vibration	Per MIL-DTL-38999 Series III Condition VI Letter J; Sine: 10 to 2,000 Hz each of three mutually perpendicular axis total of 36 hours (4 hours each ambient, -40ºC and +85ºC temperatures) Random: 43.9 rms g's random vibration 16 hours (8 hours longitudinal and perpendicular direction). No electrical discontinuity.	3.27 Sine 4.5.23.3 & 4.5.23.4 Random 4.5.23.1 IAW EIA-364-28
Shock	100 mA max with no discontinuities excess of 1 microsecond. Standard: Per EIA-364-27 – half sine wave @ 300 G. High Impact: Per MIL S 901, Grade A.	4.5 IAW EIA-364-27 IAW MIL S 901
Thermal Shock	Per IEC 60068-2-14 Test Number Nb. • Temperature range -40 - +85ºC ± 2ºC • Exposure Time: 30 min. • Number of Cycles: 100 • Test Group B contacts shall be inspected and contact resistance measured after 50 cycles and at completion of est. These specimens shall be used for humidity/thermal cycling testing.	TIA/EIA-568-B.2, A.7 IAW IEC 60068-2-14, Test Number Nb
Humidity/ Temperature Cycling	EIA-364-31 with exceptions b, d & e; EIA 364-32 Test Condition A, except steps 2 & 4 shall be 2 minutes max duration; Humidity/Temperature: TIA/EIA-568-B.2, A.8 per IEC 60068-2-38; Temperature for step 1 shall be -45 +0/-5ºC. • Temperature for step 3 shall be 85 +5/-0ºC Exposure Time: 30 min. • Number of Cycles: 100 No blistering, peeling or separation of the plating or other damage detrimental to operation of connector	4.5.11.1 or 4.5.11.2 4.5.13 IAW EIA-364-31,Method IV with temperature exceptions; IAW EIA-364-32, Test cond. A; IAW IEC 60068-2-14, Test Method Z/AD
Salt Spray	5% solution, 34º-36ºC. 48-1000 hours, depending on finish. Unmated connectors show no lifting of plated coating or exposure of basis material under 3X magnification which adversely affects performance.	4.5.13 IAW EIA-364-26
Water Immersion	1 Meter for 1 hour, Unmated	MIL-STD-810 method 512
EMI Shielding	Per IEC 60603-7, 1 MHz to 1000 MHz with effectiveness of 22 dB.	4.5.28 EIA-364-66
Fluid Resistance	Per EIA-364-10 unmated connector shall not experience any damage detrimental to performance after immersion in fluid.	4.5.30 IAW EIA-364-10

MIL-DTL-38999 Connector and Cable Assembly Material and Finish Codes

Code	Material	Finish	Finish Specification	Hrs. Salt Spray	Electrical Conductivity	Operating Temp. Range	RoHS Compliance
ME	Aluminum	Electroless Nickel	SAE AMS-C-26074	96	Yes	-65° to +200°C	Yes
MT		Nickel PTFE	SAE AMS2454	500	Yes	-65° to +200°C	Yes
NF		Cadmium, Olive Drab	SAE-AMS-QQ-P-416	500	Yes	-65 to +175°C	No
ZR		Zinc-Nickel, Black	ASTM B841	500	Yes	-65 to +175°C	Yes

MIL-DTL-38999 RJ45 Cat6a Electrical Specs for Plug & Receptacle	
Rating	Category 6a
Data rate	10GBase
Voltage rating	1000 Volts
Current rating	1.5 Amps (max)
Frequency	500 MHz (max)
Wiring	Straight through
Shield continuity	Continuous thru-coupler
Cable length	100 M (max)

RJ45/USB SUPER SEAL™

HIGH-SPEED

USB 3.0 SuperSeal

Coming Soon!

SuperSeal™

USB 3.0 connectors

The latest version of the Universal Serial Bus (USB) standard for interfacing computers and electronic devices sees a significant speed increase over the previous standard. The USB 2.0 standard offers a theoretical maximum signaling rate of 480 megabits per second, while USB 3.0 defines a maximum rate of 5 gigabits per second, more than ten times faster than USB 2.0. To achieve this, one-way communication on USB 2.0 has been dropped. USB 3.0 uses two unidirectional data paths, one to receive data and the other to transmit. USB 3.0 also provides up to 900mA of power when needed and better power management helps to conserve power when connected devices sit idle. High-sealing against fluids and dust for harsh environments with 1P67 rated sealing in an unmated condition and IP68 rated when mated, as well as improved EMI/RFI, shock and vibration protection. Scheduled for release across the following connector types: 38999, 5015, 26482 and Mighty Mouse. Glenair is commited to offering a range of connector termination options and high-speed solutions to meet the demanding communication requirements in harsh environment conditions.

- **USB 3.0 protocol**
- **High-speed data transmission rate of up to 5Gb/s**
- **High sealing capability, IP67 rated in unmated condition. 1P68 rated in mated condition**
- **Planned roll-out across all SuperSeal™ product form factors including 38999 type, 5015 type, 26482 type and Mighty Mouse Series 801, 804 and 805**
- **In development now: USB 3.0 repeater / signal booster for extended distance applications**

100 OHM

Equalizer High-Speed Micro-D

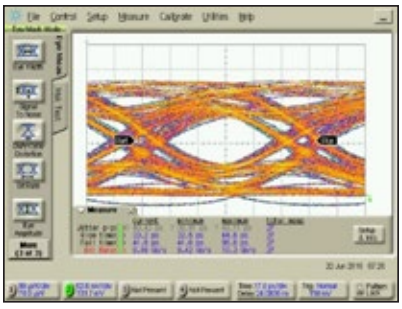
for improved signal integrity

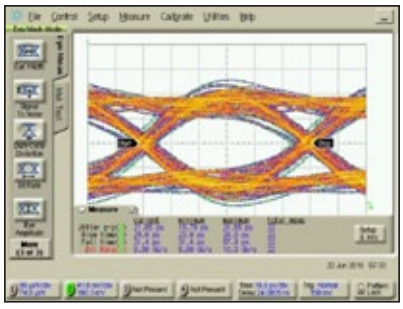
Equalizer HIGH-SPEED MICRO-D

Equalizer High-Speed Micro-D

Compensates for cable-induced losses in high-frequency/high-speed I/O-to-board applications

A new Glenair high-speed technology (test reports and sales drawings available Q1 2017), incorporating small form-factor passive board electronics that improve signal performance to achieve 10Gb/s per differential pair. The equalizer provides a scalable, matched-impedance right angle transition to the board packaged in a standard CBR style Micro-D. Integrated Equalizer technology compensates for transmission losses in printed circuit boards and cables. Technology relies on 100% passive components with no power supply required, and operates from 10Gb/s to 12Gb/s. Available initially in Micro-D packaging, the Equalizer may also be scaled for other small form-factor rectangular connectors such as the Series 79 Micro-Crimp.





Eye patterns for one channel Micro-D mated pair carrying 10 Gb LVDS
Standard construction Micro-D PCB on left, and Equalizer Micro-D on right

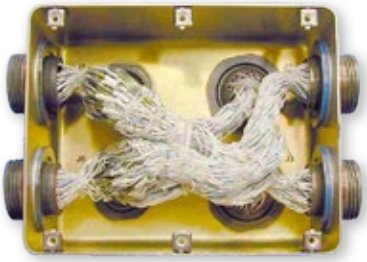
- **Initial release Q1 2017**
- **Micro-D PCB plus cordsets with matching differential pair configurations**
- **Designed for any 100 Ohm application (Ethernet, SATA, LVDS, CML, and so on)**
- **Passively equalized differential pairs**
- **Requires no power supply**
- **Improves signal integrity for 100 Ohm differential impedance**
- **Same mating interface, same contacts, same performance as standard Micro-D**

SERIES 171

AlphaLink®

Board-level spring-loaded-contact connectors and turnkey flex jumpers

AlphaLink® SL is a high-performance, solderless board-level connector technology developed by Glenair that significantly expands board-level interconnection options for users of mil-spec caliber connectors. Precision-machined and EMI shielded, these ultralightweight PC tail, solder cup, and/or pigtail equipped connectors are designed for high-reliability applications that require avionic system levels of vibration and shock tolerance. Ultra low-profile and high-density, AlphaLink® SL connectors are equipped with 2–3 Amp spring-loaded contacts and may be ordered either as discrete connectors or in turnkey flex jumpers that combine popular Glenair high-reliability I/O connectors. Glenair is perfectly positioned to provide the entire solution with in-house manufacturing for every component part—from connectors and contacts to rugged polyimide-based flex. AlphaLink® SL flex jumpers are available with Series 80 Mighty Mouse, Series 88 SuperFly, and Series 89 nanominiature circular connectors, as well as Series 89 nanominiature, Micro-D subminiature and Series 79 Micro-Crimp rectangular connectors. A wide range of insert arrangements, from 4–40 contacts is available.



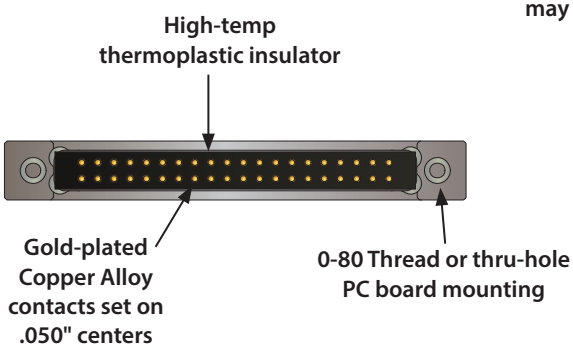
Flex offers many advantages over conventional wire, including reduced size, weight, and complexity

- **Spring-loaded, solderless board-level connector solution**
- **PC tail and solder cup versions offer easy termination to flex or wire**
- **Available turnkey I/O to board flex and pigtail wire jumpers**
- **Lightweight and low-profile—up to 40% space savings compared to 2mm pitch solutions**
- **High-density .050" center-to-center contact footprint**
- **Fast and easy PC board integration with reduced board preparation and masking**
- **Withstands temperature, vibration and shock extremes**

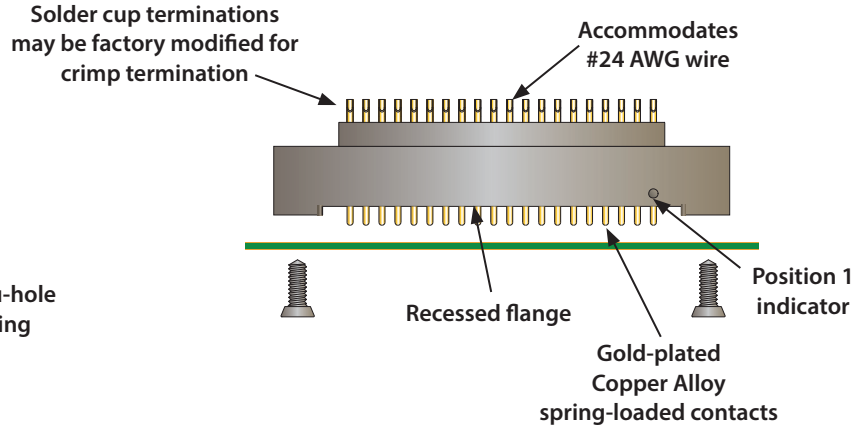
SERIES 171 ALPHALINK® SL

Spring-loaded board level connector Design features

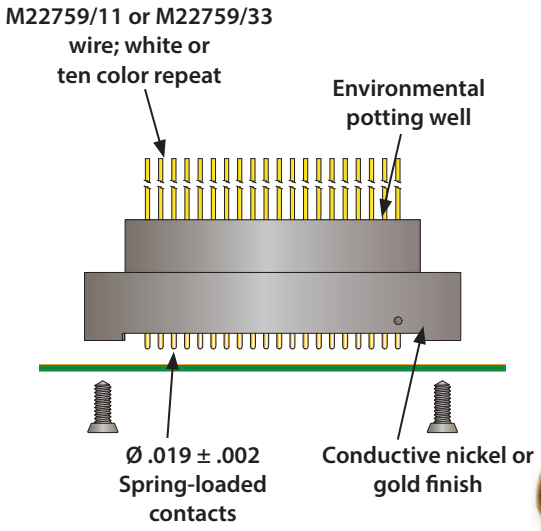
AlphaLink® SL Spring-Loaded Contact Interface



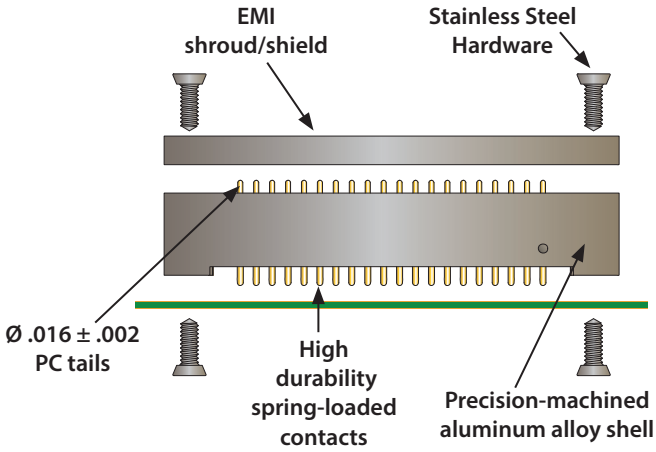
171-134-01 Solder Cup Termination



171-134-03 Wire Pigtail Termination

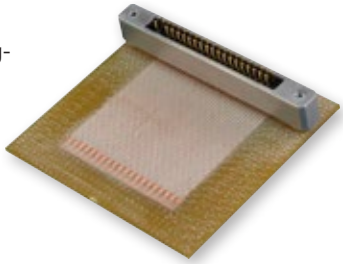


171-134-02 PC Tail Termination



AlphaLink® SL flex jumpers: Compact interconnect assemblies that combine circuit board technology and cabling into a lightweight, integrated package. These turnkey jumper assemblies reduce system size and weight and are ideally suited for prototype applications and new product development efforts.

AlphaLink® SL spring-loaded contact PC board connectors deliver up to 50% footprint savings versus conventional 2mm pitch solutions. PC tail equipped connectors, the 171-134-02, are supplied with an EMI shroud / shield for improved EMC compared to low-cost plastic board connectors. All connector styles incorporate a high-reliability spring-loaded contact that delivers a virtually unlimited number of mating cycles. Connectors are typically mated to the PC board using conductive pads or via's. Stainless steel mounting hardware provides a robust, vibration-resistant attachment solution compared to stamped-and-formed retention barbs.



Glenair®

For more information contact Glenair at **818-247-6000** or visit our website at **www.glenair.com**
U.S. CAGE code 06324

PARYLENE-COMPATIBLE

Circular and Rectangular PC Tail Connectors

PARYLENE COMPATIBLE

Parylene-compatible PCB connector. Encapsulant potting material fully seals internal components of connector during parylene vacuum deposition process.

Environmental and hermetic

Parylene conformal coating protects PCBs against moisture, contaminants and corrosion, ensuring a longer electronic system life cycle. During the vapor deposition process (which takes place under vacuum), parylene will penetrate and coat all unprotected surfaces of PCB connectors if not effectively sealed, potentially resulting in increased resistance or other electrical problems. The use of temperature, shock, and vibration-tolerant epoxy potting (environmental) or glass-to-metal (hermetic) sealing on PCB connectors prevents parylene ingress into the component. All Glenair PCB connectors presented in this selection guide have been tested and qualified for compatibility (sealing and ingress protection) with parylene conformal coating processes.

Non-parylene-compatible PCB connector. Resilient rubber seal is wholly inadequate to the task of sealing internal / conductive connector components during parylene vacuum deposition process.

SUPERNINE® D38999 SERIES III POTTED/SEALED PCB CONNECTORS

233-207
flush-flange receptacle

233-208
stepped contact receptacle

233-209
short standoff receptacle

233-210
threaded standoff receptacle

233-211
dual flange receptacle

233-218
high-speed hybrid with threaded standoffs

257-859
PCB receptacle with compliant pin contacts

PARYLENE-COMPATIBLE

Circular and Rectangular PC Tail Connectors

Environmental and Hermetic

PARYLENE COMPATIBLE

SERIES 80 MIGHTY MOUSE POTTED/SEALED PCB CONNECTORS

805-005
Epoxy-potted receptacle

805-011
right-angle receptacle

805-067
square flange jam nut receptacle

8070-1444
805 series dual-flange

SUPERSEAL RJ45/USB PCB

233-302
D38999 RJ45 jack receptacle

805-342
Mighty Mouse USB receptacle

NANOMINIATURE 32139 TYPE POTTED/SEALED PCB CONNECTORS

893-008
breakaway straight

893-009
threaded straight

893-010
breakaway right-angle

893-011
threaded right-angle

SERIES 88 SUPERFLY PCB

881-019R
threaded vertical receptacle

881-020R
threaded right-angle receptacle

MIL-DTL-83513 MICRO-D PCB CONNECTORS

MWDM-BS
vertical mount thru-hole PCB connector

MWDM-BR
right angle-mount thru-hole PCB connector

MWDM-CBS
vertical mount thru-hole condensed PCB connector

MIL-DTL-32139 NANOMINIATURE PCB

890-006/-007
single-row vertical PCB plugs / receptacles

890-008/-009
single-row right angle PCB plugs / receptacles

891-006/-007
dual-row vertical PCB plugs / receptacles

SERIES 28 HiPer-D M24308 STANDARD AND HIGH-DENSITY PCB CONNECTORS

280-022
straight PC tail pin connector

280-023
straight PC tail socket connector

280-024
right-angle PC tail pin connector

280-025
right-angle PC tail socket connector

280-026
straight PC tail pin connector, low-profile

SERIES 28 HiPer-D M24308 COMBO-D PCB

280-054
combo straight PC tail pin connector, low-profile

280-055
combo straight PC tail socket connector, low-profile

280-056
combo right-angle PC tail pin connector, low-profile

SERIES 79 MICRO-CRIMP PCB CONNECTORS

790-028
straight PC tail panel receptacle

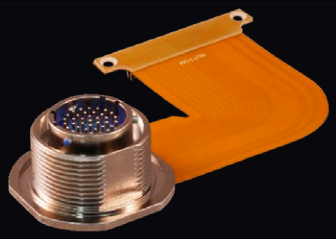
790-029
straight PC tail panel plug

Integrated PCB/Flex Assembly Production Lab

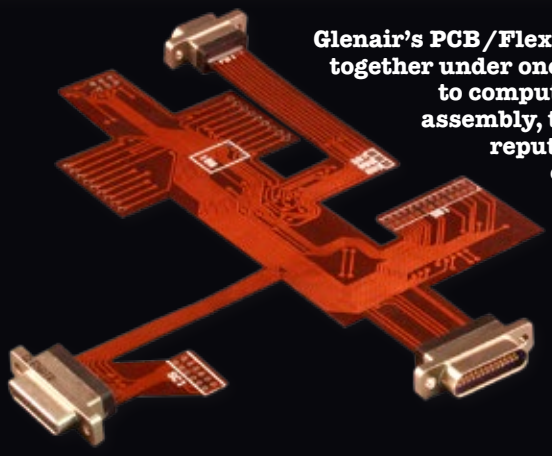
GLENDALE, CALIFORNIA

IPC 6012/6013 Class I, II, III, types 1–4
ISO 9001, AS9100 Certified

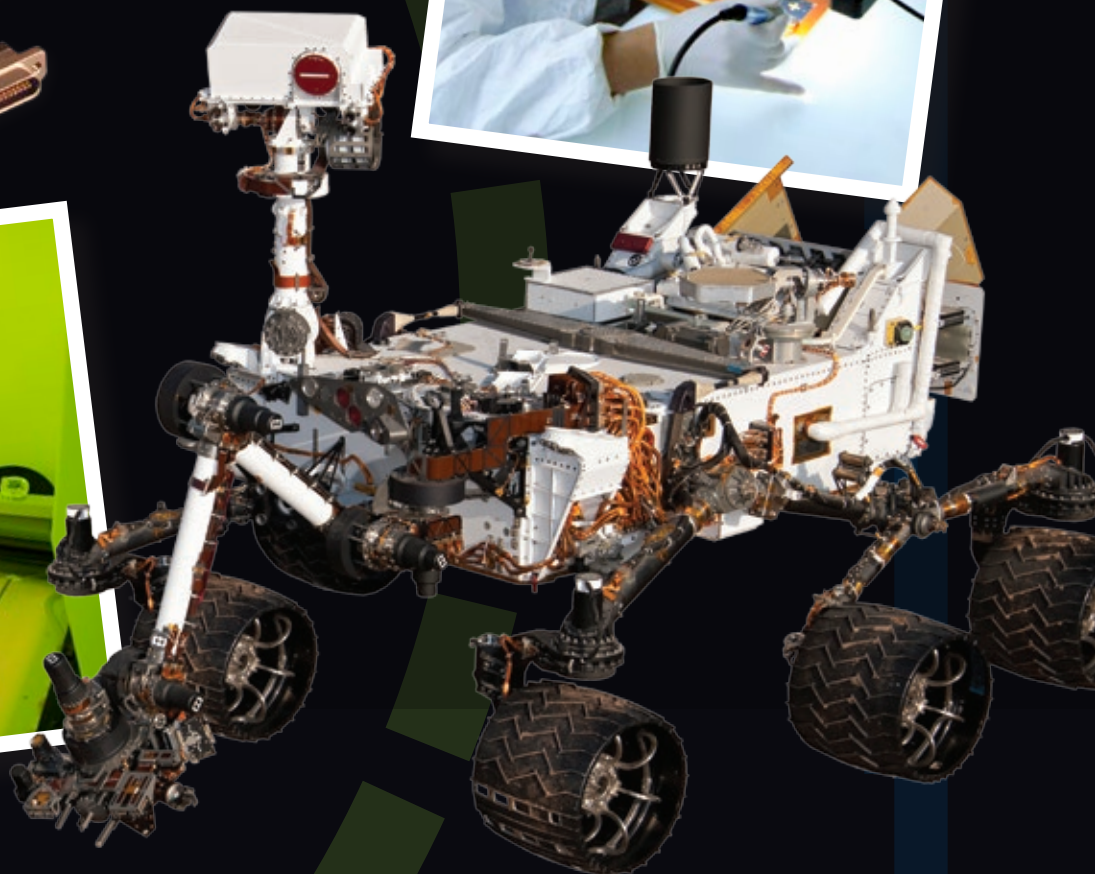
integrated PCB/Flex assemblies



Glenair Integrated PCB/Flex assembly production facilities are operated in accordance with commercial and military standards. Staff includes 200+ PCB and cable assemblers with Nadcap certification for special processes and ESD management.



Glenair's PCB/Flex interconnect team is housed together under one roof. From electrical design to computer-aided manufacturing and assembly, the team has a well-deserved reputation for on-time delivery of even the most complex PCB/Flex assemblies.



Outlook

Why the Boy Scout?

We had a visitor to the factory this past week who was intrigued with our Glenair Guiding Principles. Regular readers of *QwikConnect* will know that we take these principles seriously, as they have been instrumental to our now sixty-plus years of success in the high-reliability interconnect industry. Anyway, this visitor, a customer, was keenly interested in our first and foremost principle to "protect the reputation of the organization"; in particular why we had chosen a Boy Scout to illustrate the point in the poster on the wall. I explained that Norman Rockwell's Boy Scout was, in our view, the perfect symbol to convey the dedication and duty we expect at Glenair when it comes to ethical behavior in the workplace. I went on to say that in our "quaint" way of doing things, we prefer not to burden folks with a long list of rules. Instead—much like the scouts—we strive to communicate the values and principles we hold dear and trust our colleagues to join us in their application.

Well, you should have seen him smile. A life-long scout, he was visibly proud to see the organization's reach had extended into our company culture in such a meaningful way. And truth be told, our walking tour of the factory paused at that poster for a solid half hour as we talked about leadership, citizenship, duty, and other scouting principles that we both agreed are relevant in today's business world. On the topic of leadership, we discussed how effective leadership begins with "follow ship"—or the practice of giving everything you have as a regular team member that ultimately prepares you for the role of leading teams yourself. And as is natural for a supplier and customer, we talked a bit about customer service. Specifically, we agreed that the Boy Scout Law (which he of course knew by heart: trustworthy, loyal, helpful, friendly, courteous, kind, etc.) would make a great foundation for outstanding customer service in any organization that took the task seriously.

An observation about Glenair bears on this point: every group in our organization has a customer service aspect to its work. From inside sales, to field application engineering, quality, production, inventory-control—you name it—we all have internal and external customers. At the risk of beating the same old drum, I'm proud of our team when it comes to treating all of our many customers with honest, friendly service. Sure, sometimes we slip on a banana peel (despite our best efforts) and come up short in the customer's eyes. But it has certainly been my experience that we all do a pretty good job of *protecting the reputation of the organization* when it comes to ethical and reliable service to our customers, colleagues, and suppliers. As Teddy Roosevelt once said, "The most important single ingredient in the formula for success is the knack of getting along with people." I couldn't agree more.

Chris Toomey

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