QwikConnect

GLENAIR • JULY 2020 • VOLUME 24 • NUMBER 3

SMALLER
LIGHTER
FASTER

MOVING DATA FAST IN RUGGED ENVIRONMENTS

Glenair®

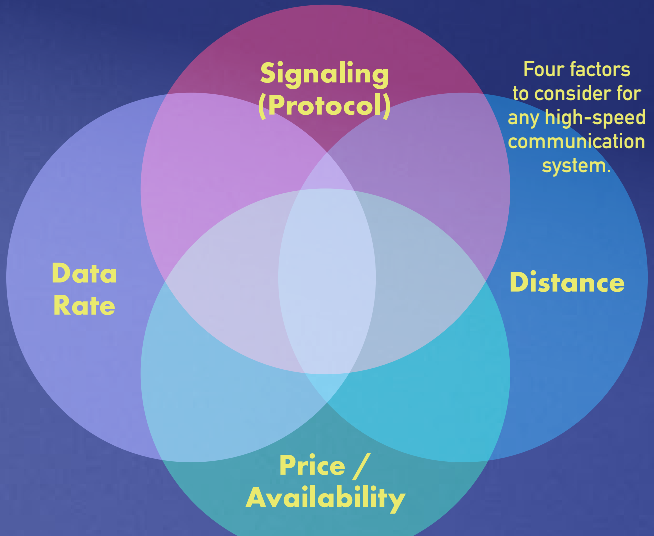
SMALLER
LIGHTER
FASTER

MOVING DATA FAST IN RUGGED ENVIRONMENTS

Introduction

High data-rate transmission protocols—and interconnect hardware—have undergone significant upgrades over the past decade. Glenair has stayed on the forefront of this evolution by developing contacts, connector and wiring solutions with increasingly faster and better performance. Our approach has been a mix of upgrades to traditional packaging (such as new high-speed Micro-D designs), as well as the pioneering of entirely new solutions (such as our signature differential Twinax platform, VersaLink).

This special edition of QwikConnect is a fairly technical "Deep-Dive" into the underpinnings of modern-day data-transmission protocols, and how Glenair ensures optimal signal integrity and rugged environmental performance throughout our extensive range of mil-aero caliber solutions. When appropriate, we also delve into the underlying physics of high-speed (copper) datalink transmission, especially when it may help to clarify key concepts and assist application engineers in making good technology choices and designs.



Four factors to consider for any high-speed communication system.

High-speed copper links

Product selection for high-speed copper datalinks normally revolves around four key parameters: distance, data rate, signaling (protocol), and price/availability. Once those parameters have been established, mechanical, ergonomic, and environmental requirements may be applied to select a suitable interconnect package or envelope. Given the wide array of possible environmental conditions—such as extreme operating temperature or severe levels of vibration—this is often a significant challenge, especially when it comes to the specification of suitable cable. In high-speed digital data transmission, just as with RF links, connectors must always be selected in tandem with their wiring. In this regard, the wire-to-contact termination methods and quality can massively impact system performance. As all the EE's reading this article know, electromagnetic energy does not exactly propagate inside the wires themselves but in the materials that surround them. So the definition of a cable and contact system involves much more than just picking a wire gauge or specifying insulation thickness. The devil here truly is in the details! More about this as we go.

A standard Ethernet segment is limited to 100 m in length over Cat5 cable—adequate for wiring the IP-enabled devices within an aircraft.

A "link budget" is an accounting of all of the power gains and losses that a fast communication signal experiences—node-to-node, from a transmitter, through a cable to the receiver.

DISTANCE: As a preamble, lets take a look at just one of the key parameters mentioned, that of distance. The first consideration in looking at a transmission link is the distance to be traveled (and number of breakpoints). Obviously, the further a signal must travel, the more focus must be applied in budgeting for signal degradation from cable loss.

In a typical local area computer network application, a node-to-node copper connection will rarely exceed the maximum allowed by conventional Ethernet standards (approximately 100 meters). This maximal distance is typically adequate to wire up computerized devices within a building—or an aircraft, spaceship, submarine, or other defined space. Beyond this distance, in-line electronics such as repeaters and re-drivers (supplied by Glenair for all protocols including USB, DVI, and HDMI) are required. Conversion to optical fiber is also a reliable option.

Interconnect challenge: keeping pace with computer-control devices and protocols

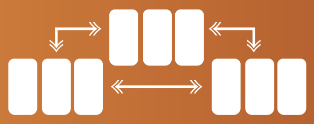
The next distance category is computer peripherals. Distances here typically range from 0.5 meter to 15 meters. The primary consumers of high-speed bandwidth in this range are high-resolution video feeds, sensors, radars, and avionic box connections. Rapid growth of computer-control device types and applications has meant that the lifespan of chip technology is relatively short. This is evident in the rapid evolution of the high-speed protocols addressing this space (e.g. HDMI, DisplayPort). Many of the chipsets developed for these protocols are now making their way into rugged systems. But while new chipsets are easily implemented at the logic and PCB level, interconnects and cables often require more specialized development. Witness the persistence of RJ45 and legacy USB interconnects in otherwise cutting-edge application environments.

The shortest links of concern to those of us in the interconnect realm are 'inside the box.' These connector and cable sets rarely see full system environmental conditions, and include PCB to I/O datalinks, board-to-board and modular disconnects, and intra-board 'fly-over' cable links.

BREAKPOINTS: We've talked about distance, and made the point that there are distance limits in high-speed copper systems that play out at the network, peripheral and board levels. The next consideration in the equation is the inclusion of connector breakpoints in link budgets. Breakpoints are particularly challenging because many protocols have rigid link configurations baked into the standards (the USB standard, for example, was not written for any additional connectors in the link). The same is true for most peripheral data transmission protocols.

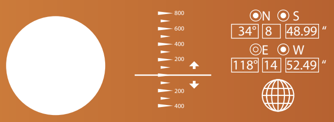
In military and aerospace systems, a relatively hard-wired configuration does not meet the needs of most applications and link budgets, and must be re-evaluated for each additional breakpoint connector and cable length. A naval command post, for example, may be 100 feet away from a data center, and the link may need to traverse any number of bulkhead disconnects. Glenair does offer a full range of re-drivers and repeaters for these situations. These devices can be built directly into the cable side of a connector or can be implemented with an over-molded device on the cable, much like a ferrite bead.

DATA TRANSMISSION DISTANCES AND APPLICATION FAMILIES



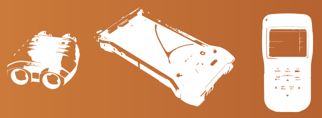
Networks: Mainframe, server, and system-to-system networks

- Dominated by Ethernet protocols
- Ever-increasing bandwidths, driven by peak demand
- "Tree" structure with switches and routers
- Flexible configuration, user-modified as nodes are added or removed



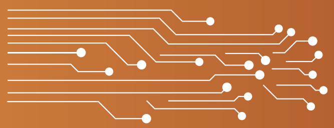
Sensing and Control: Links between a computer and monitored or controlled devices

- Ruggedized / environmental
- Long connection distances (longer with re-drivers and repeater devices)
- Broad range of bandwidths
- "Daisy chain" configuration
- Stable installation, not usually user-modified



Peripherals: specialized device interfaces connected to a computer

- Short connection distances (a few yards maximum)
- Cover a broad range of bandwidths
- Serial (bit-by-bit) or Parallel (multiple data streams)
- "Star" configuration
- Stable installation, not usually user-modified



Board Level: Short-distance board-to-I/O and board-to-board

- Data-intensive servers, computers and peripheral devices
- Transmission rates in the 10Gb/s+ range for each data pair.
- Supports serial data protocols (USB 3.1 Gen2, USB-C, SATA, PCIe, DisplayPort, and HDMI)

Board-to-board segment lengths—measured in millimeters—are still of critical concern in high data throughput applications. In the photo above, an Air Force Avionics Technician visually inspects a circuit card for a C-17 Heads-Up Display.

Data Rates and Rugged Environments

The relative ease of implementing high-speed copper data transmission in electronic systems has led to a rapid increase in demand for sophisticated datalinks that operate flawlessly in the most extremely rugged application environments.

Data transmission rates between avionics modules onboard spacecraft, for example, continue to increase, driven by the use of processors with multi-gigabit-per-second high-speed serial data I/O's. These complex systems support the growing data requirements of onboard sensors and increased bandwidth requirements between communications switches and satellite communication terminals. High-speed / high data rate links that can support data rates up to 10 Gbps per channel, are increasingly common in these rugged application environments.

A few additional examples would include the proliferation of sub-sea, terrestrial and airborne sensor and surveillance systems, as well as the increasingly sophisticated data processing capabilities in mobile command posts, soldier systems and navy platforms. The high-data rate technologies developed in these contexts sometimes also find unexpected uses in nuclear plant applications and even quantum computers.

Sensors with high-speed data links are used in flight controls, environmental monitoring, sensor systems. and so on. Photo: The NASA-ISRO SAR Mission

THE PHYSICS OF HIGH-SPEED SIGNAL INTEGRITY

Three key tools used in measuring source-to-load power losses in interconnect data links.

INSERTION LOSS:

The Insertion loss of a link, or a portion of a link is a measure of the circuit resistance, or simply the amount of power lost during the transmission. For a section of a cable, the power lost follows an exponential decay per unit length. It's important to distinguish between power and voltage, because the rules for addition for power and voltage are different. Power is a real number. AC voltage is a real number times a phase:

1 Watt plus 1 Watt is always 2 Watts

But AC voltage at a given frequency:

1 Volt plus 1 Volt is anything between 0 and 2

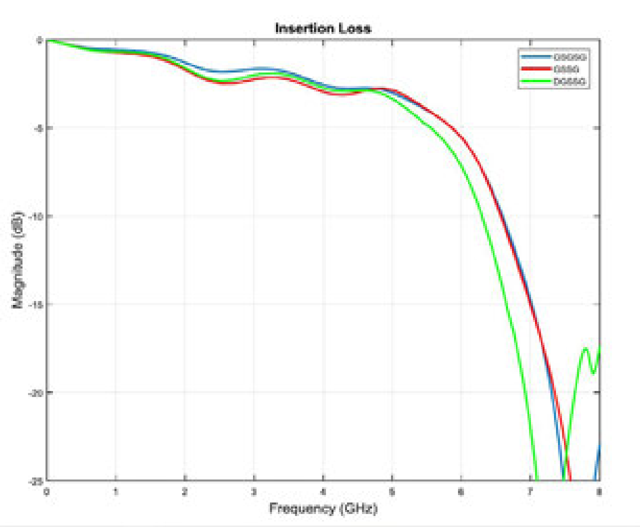
depending on how the phases line up. Most link budgets are estimated using power, because it's simple. But in complex links with multiple connectors, the effects of phases must be considered, resulting in insertion loss being expressed in logarithmic form:

IL= Log10(power_in/power_out)

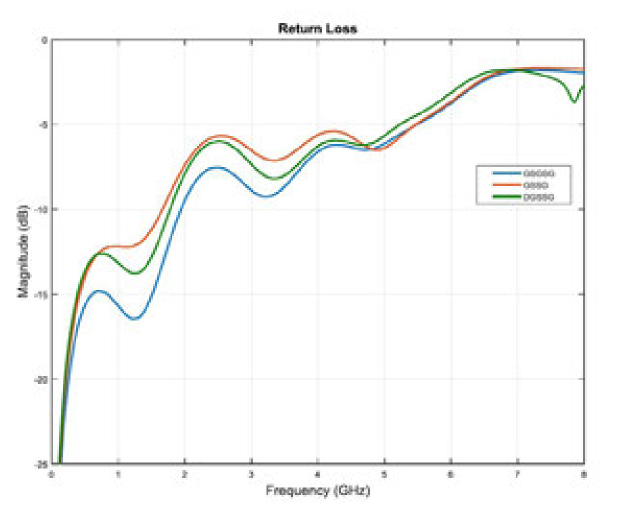
RETURN LOSS:

When power is lost in a link, it can be either due to the circuit resistance (insertion loss), or it can be lost because some portion of the signal was reflected back into the link (in optical fiber transmission the same phenomenon is often referred to as back-reflection). Losing the signal to ohmic loss or to reflections has a different impact on the quality of what we receive, therefore both numbers are important when considering the quality of a connector or a cable.

The cause of return losses is a change in impedance along the link, often at the connectors, but potentially originating in the cable due to a kink, sharp bend, or construction defect. Intermittent defects in a cable (for instance due to restrictions from taping or braiding) can create strong return-loss reflections at certain frequencies, as if a mirror had been inserted into the system.



This measurement of insertion loss from a HD Stacker high-speed board-to-board connector shows -3dB insertion loss at 5.6 GHz for an effective electrical bandwidth of 12 Gbps



This measurement of return loss from a HD Stacker high-speed board-to-board connector shows -3dB insertion loss at 5.6 GHz for an effective electrical bandwidth of 12 Gbps

IMPEDANCE MATCHING:

Electrical impedance, or simply “impedance,” describes a measure of opposition to alternating current (AC). Electrical impedance extends the concept of resistance to AC circuits, describing not only the relative amplitudes of the voltage and current, but also the relative phases. When the circuit is driven with direct current (DC), there is no distinction between impedance and resistance; the latter can be thought of as impedance with zero phase angle.

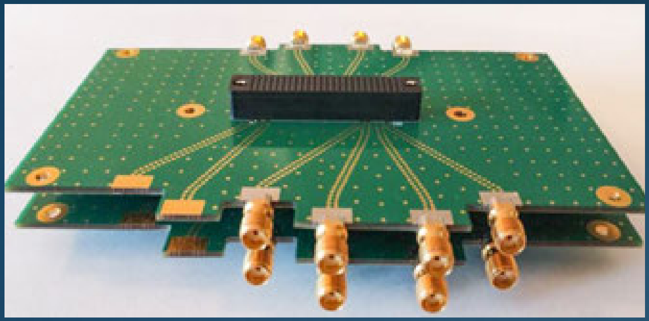
How Impedance is Measured: A Time Domain Reflectometer (TDR) transmits a short rise time pulse along the conductor. If the conductor is of a uniform impedance and is properly terminated, the entire transmitted pulse will be absorbed in the far-end termination and no signal will be reflected toward the TDR. Any impedance discontinuities will cause some of the incident signal to be sent back towards the source.

Increases in the impedance create a reflection that reinforces the original pulse, while decreases in the impedance create a reflection that opposes the original pulse. The resulting reflected pulse is displayed or plotted as a function of time, and because the speed of signal propagation is almost constant for a given transmission medium, it can be read as a function of cable length.

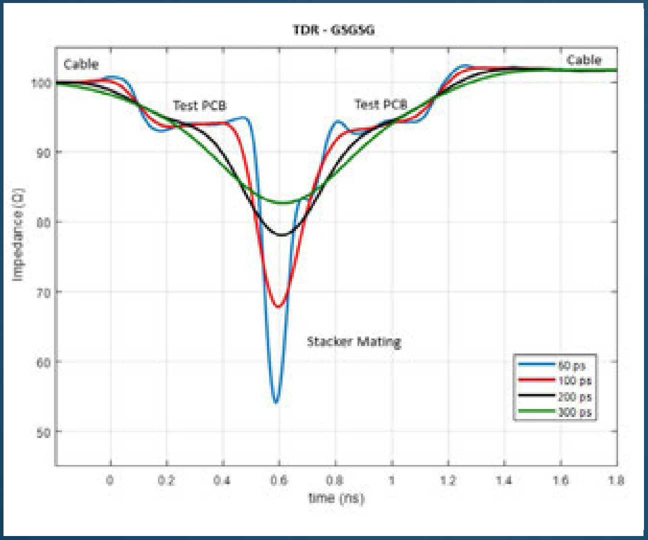
Impedance matching is the practice of designing the input impedance of an electrical load or the output impedance of its corresponding signal source in order to get maximum power transfer from source to load.

When we maximize the contact density in a connector, the conductors invariably come into closer proximity. This decreases the impedance between them. The relative Impedance can be thought of as the amount of electrical coupling there is between the conductors. Most protocols covered in digital signal transmission, require an impedance in the range of 75 to 120 Ohm.

In a micro-D connector, the impedance between two adjacent contacts is on the order of 30 Ohm. In order to increase this value, we must either reduce the dielectric constant of the inserts (the best we can typically achieve is with Teflon which has a dielectric constant of 2.2. Air has a dielectric constant of 1, (but of course using air as the dielectric in a connector is not mechanically possible). Alternatively, we can increase the spacing between contacts (sacrificing the connector’s high density). A third approach would be to maintain the same contact-to-contact spacing, but use smaller contacts overall (resulting in a lower-amperage connector). In all three cases the goal remains the same: that of maintaining a high contact density count while maximizing power transfer from source to load.



Impedance testing of differential contact pairs in multipin connectors makes allowances for ground pin separation of signal pairs. This test board has been wired for a Ground-Signal-Ground-Signal-Ground (GSGSG) method of impedance testing.



TDR testing is used to find the best balance between connector density and return loss. Depending on the application link budget, decisions can be made on which arrangements of grounds to signal contacts is optimal for a given dB return loss and frequency.

Glenair
SIGNATURE SERIES

HIGH-SPEED PLATFORMS AT GLENAIR

Rugged high-speed interconnect solutions with signature contacts and contact modules for mission-critical aerospace and defense applications.

The ongoing dilemma for system engineers (and interconnect suppliers) is to design in scalable and reliable technology platforms that can keep pace with the rapid evolution in chip-level electronics, as well as the growing demand for faster and higher data rate applications. On the interconnect side, the best path forward is invariably to innovate with higher-speed and higher data rate designs that nevertheless incorporate proven modular contact designs, low-resistance crimp terminations, common mating technologies and other known "standards" of the industry. The practical consequences are that proven designs, such as verified approaches to shielding, impedance management, cross-talk and other factors are carried forward with each new technology.

At Glenair we separate our high-speed offerings into two categories: 1) drop-in contact solutions (including the octaxial El Ochito), and 2) special contact / insert solutions (including SpeedMaster, and the High-speed Micro-D). The former may be packaged in industry-standard connectors, the latter are insert modules available only in Glenair Signature Series packaging.

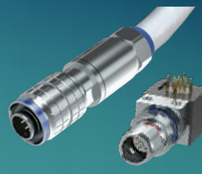
El Ochito: This size 8 Octaxial contact is a step curve improvement over Quadrax for 10/100 Base-T Quadrax aircraft Ethernet applications. Migration to higher speeds on legacy Quadrax requires splitting signals into two cables and two size 8 cavity contacts with considerable damage to signal integrity. El Ochito is a high-density solution that allows seamless upgrades to 1G and 10G Base-T. The drop-in size #8 El Ochito contact is compatible with D38999, Series 806 Mil-Aero, and other ruggedized packaging. Aerospace-grade cables with crimp termination are standard.

Building on the success of El Ochito for Ethernet, we developed a version for USB 3.X protocols—distinguished by its blue color—an improved signal integrity design required for the 5-fold increase in base bandwidth needed by USB 3.X over 10GbE. We also offer a 100 Ohm high-speed 4-pair solution suitable for HD digital video transmission.


SuperSpeed USB


HDMI, DisplayPort, SATA


El Ochito® high-speed octaxial contacts


El Ochito® shown packaged in a SuperFly Datalink board and cable pair


Series 23 SuperNine® with SpeedMaster™ 10G high-speed module insert


SuperSeal™ RJ45 Ethernet and USB ruggedized field connectors


Octobyte™ industrial-strength Ethernet connectors


High-Speed Micro-D: high-density solution with TwistPin contacts


VersaLink™ and VersaLink™ Bridge: differential Twinax solution shown here in Micro-D packaging


Active electronic Repeaters and Re-Drivers available for all connector series

SpeedMaster: While we are huge fans of El Ochito, not every customer needs the high density of octaxial size 8 contacts. Some prefer the flexibility of using a larger gauge wire, with AS39029 size 22 contacts and common crimp tools to terminate their high-speed interconnect. For this reason, we offer SpeedMaster connectors, with slightly larger, non-standard cavities that enable the use of the larger wire gauge and special SpeedMaster shielded contact.

Octobyte: Glenair Super ITS Octobyte™ connectors with Ethernet-ready contact modules (for CAT 5 to CAT 7A, and RG58 Coax) are available for harsh-environment military and industrial applications that depend on sealed environmental (IP67) connector performance. These crimp-termination (not insulation displacement) connectors deliver both dedicated Ethernet as well as mixed serial databus and power for high-speed data applications. Reverse-bayonet connectors are fast mating and deliver reliable locking performance in vibration and shock applications.

SuperSeal: Military-grade, ruggedized field connectors that deliver improved environmental sealing, EMI/RFI grounding, and a broader range of wire termination options for standard commercial RJ45 and USB interconnects—now available for SuperSpeed 3.0. One unique advantage of our SuperSeal product family is that any commercial connector will be able to mate with the product. The connectors offer a wide array of cable termination options, ranging from PC Tail configurations, to “drive-thru” designs and crimp removable contacts.

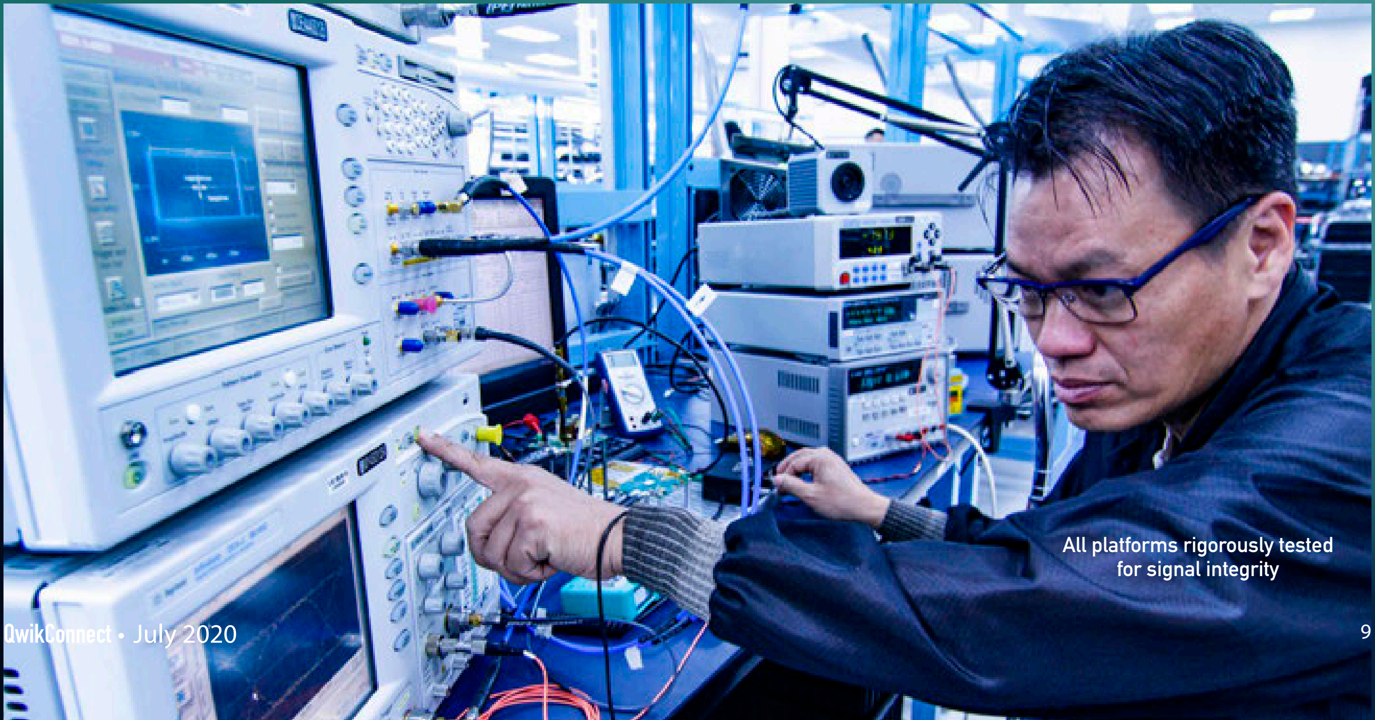
VersaLink: El Ochito covers a vast array of applications and protocols. The size 8 contact with 4 differential pairs has limits however. First, it obviously only comes in increments of 4 pairs and requires a size 8 cavity. If the goal is to carry as many pairs as possible in the smallest volume, and the pair quantization is not in increments of 4, then El Ochito may not be the best solution. This led to the development of VersaLink:

VersaLink Micro-D connectors, available in board-mount styles, pre-wired with pigtails, or as back-to-back cordsets.

- A single contact module for each differential pair
- The highest possible density per shell size
- Ample bandwidth for all common protocols
- Simple, user-friendly, fast termination process
- Versatile packaging: rectangular and circular
- End-to-end solution: board and I/O connectors use the same electrical core.

High-Speed Micro-D: The micro-D and nano-D connector families are small, high-density solutions historically used for parallel signal transmission. In fact, these are the smallest connector families available in the Mil-Aero market segment and as such are natural candidates for re-engineering to meet the signal integrity and impedance-matching specs necessary for high-speed datalink transmissions.

Repeaters and Re-Drivers: Active cable technologies, geared to individual high-speed protocols, that extend distance limitations and enhance signal integrity as necessary in high-speed datalinks.



All platforms rigorously tested for signal integrity

HIGH-SPEED PROTOCOLS IN ACTION

Data networks are divided into layers, each performs a function in the transmission of data. The connectors, cables and the general electrical description of the signal (number of wires, frequency spectrum, type of modulation technique, encoding etc..) are part of the lowest layer, called the physical layer (PHY). The description of the physical layer should contain everything needed to create a link with wires and connectors. We will provide a shot description of the most commonly encountered protocols below.

Ethernet

The computer network standard as produced by the IEEE 802.3 working group since 1983. It has evolved from speed of a few Mb/s to 400Gb/s. The transmission medium ranges from Coax, twisted pairs to optical fiber. Readers are likely familiar with the 1000Base-T designation. The nomenclature for newer designations is shown in the table below.

The encoding method scrambles the data to balance its average voltage value, X and R identify the size of the encoding blocks. The number of lanes indicates how many data pairs (for electrical) per link.

Ethernet cables plugged in to Ethernet switches in a server room.
Photo by Jon 'ShakataGaNai' Davis, Wikimedia Commons

So for instance 10Base-T1 is a 10Mb/s DataStream, where the voltage is modulated directly with 1's and 0's over a single twisted pair (this is used in automotive and industrial applications). This nomenclature has not been implemented consistently, and short-hand descriptions are frequent.

It is important to note that the physical layer will often contain a description of the connector to be used (for example, 8P8C in the table is the official name of what's usually called an RJ45). At a minimum it will define the necessary electrical performance.

A selection of popular and state-of-the-art protocol standards is provided in the table below.

Ethernet Nomenclature	**XXXXG**	**BASE**	**–T**	**X**	**4**
Usable Speed	in Mb/s or Gb/s if followed by a **G** (**10**, **100**, **1000**)				
Signaling Spectrum	(**BASE**, **BROAD**, **PASS**)				
Medium Designation	**-T**, **-S**, **-L**, **-E**, **-Z**, **-B**, **-P**, **-C**, **-K**...				
Encoding Method	(**X**, **R**)				
Number of Lanes	(**1**, **2**, **4**, **10**)				

Popular Ethernet Protocol Standards

Name	Standard	Connector	Description
100BASE-TX	802.3u-1995 (24, 25)	8P8C (FDDI TP-PMD standard, ANSI INCITS 263-1995)	Category 5 cable using two twisted pairs. Still very popular.
1000BASE-T	802.3ab-1999 (40)	8P8C (IEC 60603-7)	PAM-5 coded signaling, at least Category 5 cable, with Category 5e copper cabling with four twisted pairs. Each pair is used in both directions simultaneously. Extremely wide adoption.
1000BASE-KX	802.3ap-2007 (70)		1 m over backplane
10GBASE-T	802.3an-2006 (55)	8P8C (IEC 60603-7-4 (unscreened) or IEC 60603-7-5 (screened))	Uses Cat 6A twisted-pair wiring, four lanes at 800 MBd each, PAM-16 with "DSQ128" line code
10GBASE-KX4	802.3ap-2007 (48&71)		1 m over 4 lanes of backplane
10GBASE-KR	802.3ap-2007 (49&72)		1 m over a single lane of backplane

Ethernet Nomenclature Descriptions

XXXXG: Usable speed is the amount of data per second the link can transmit

BASE: Signaling spectrum refers to the frequency range used by the signaling. Baseband means there is no modulation other than the bits turning on or off. Broadband means that multiple frequency channels are individually modulated. Passband means that the signal modulation is confined to a narrow frequency band (the pass band).

X, **R**: Encoding block size

The medium designations are:

T: Twisted pair wire
S: Short wavelength multi-mode optical fiber (850nm)
L: Long wavelength single mode optical fiber (1300nm)
E (or Z): Long wavelength single mode fiber (1550nm)
B: Bi-directional optical optical fiber, using different wavelengths
P: Passive optical network
C: Copper/Twinax
K: Backplane

Some readers may wonder why there is an Ethernet protocol for backplanes. This has emerged from embedded systems (or computers), where the computation capacity can be increased modularly by populating more slots in a backplane. The communication protocol of choice is still Ethernet, but the physical link is so different that it warrants its own family of specifications.

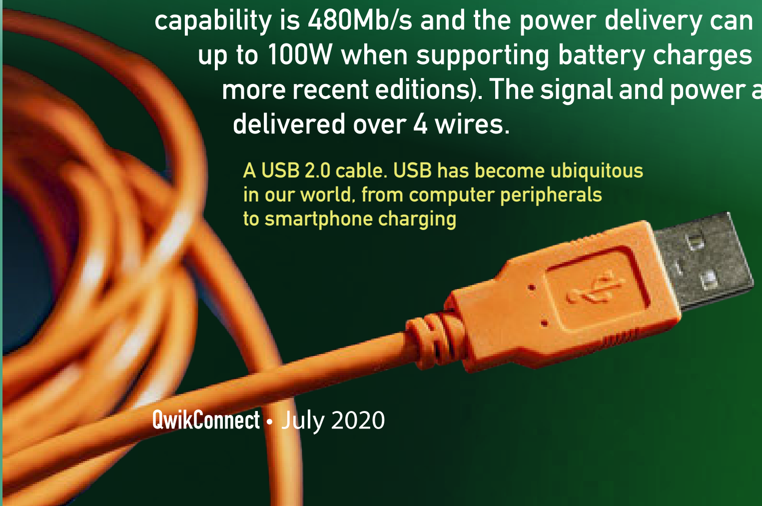
USB

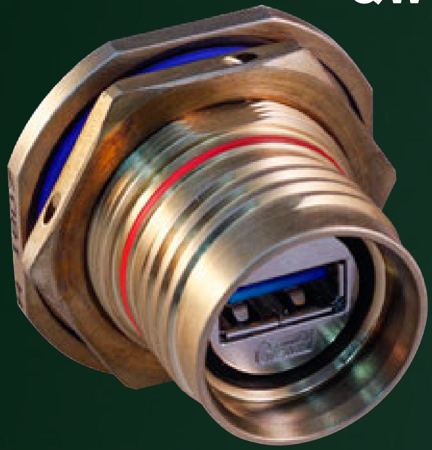
After Ethernet, this is the most widely deployed mode of data transmission. But unlike Ethernet, it is not a network protocol and is meant to be used as a point-to-point connection between a host and a device (or several devices). As mentioned earlier, the product lifespan is shorter for devices using this protocol, and the protocol revisions are frequent. It also tends to be closer to a user and have more frequent mating cycles compared to Ethernet connections. Ruggedizing USB links is more challenging than traditional Ethernet because the signal spectrum reaches to much higher frequencies, and because the link configuration budgets do not explicitly allow for disconnect points.

Evolutions of the USB standard have revolved around higher data rates and more power delivery options (battery charging and device power). The most significant recent hardware development is the USB-C connector because it merges the serial port standard with display capability; HDMI and DisplayPort can both be carried through a USB-C cable.

USB 2.0

This protocol just turned 20 years old a few months ago, roughly the same age as our Mighty Mouse connector family. It's interesting to note that to this day, a double digit percentage of our Mighty Mouse connectors we ship end up carrying USB 2.0 because that's what most soldier systems use to connect the various devices. The maximum data transmission capability is 480Mb/s and the power delivery can go up to 100W when supporting battery charges (in more recent editions). The signal and power are delivered over 4 wires.


A USB 2.0 cable. USB has become ubiquitous in our world, from computer peripherals to smartphone charging


Glenair offers USB 3.0 connectors in ruggedized mil/aero connectors with outstanding metal-to-metal grounding and enhanced environmental sealing (IP68 in mated condition)

USB 3.0

Just 10 years after its predecessor, this protocol was a major revision in terms of speed and largely backward compatible. But with the addition of 2 SuperSpeed pairs, the link can support close to 10 times the data rate of USB 2.0. The hardware implementation looks exactly like USB 2.0 (except for USB-C cables which we will discuss in more detail below), but the electrical requirements are different. SuperSpeed USB connectors are distinguished by the blue color of their inserts. Rugged implementations of this protocol require much closer attention to signal integrity compared to USB 2.0, impedance matching through the interconnect is very important.

Ensuring backwards compatibility has led to a strange nomenclature, where newer revisions of the specifications re-named the older protocols. The table below identifies the relationships between the specification, protocol, brand and data transmission rate

USB 3				
Specification	Name	Previous Name	USB-IF Branding	Transfer Speed
USB 3.0	USB 3.2 Gen 1	USB 3.1 Gen 1	SuperSpeed USB 5Gbps	5 Gbit/s
USB 3.1	USB 3.2 Gen 2	USB 3.2 Gen 2	SuperSpeed USB 10Gbps	10 Gbit/s
USB 3.2	USB 3.2 Gen 2 x 2	N/A	SuperSpeed USB 20Gbps	20 Gbit/s

Cables for USB 3.X protocols require two high-speed pairs, a power pair and the legacy data pair to support USB 2.0.

HDMI

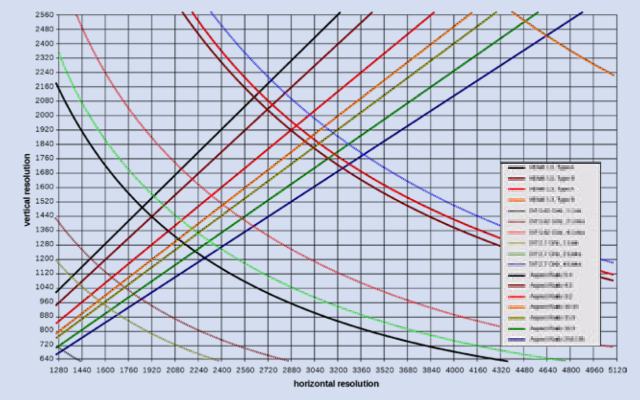
HDMI (High-Definition Multimedia Interface) is a compact audio/video interface for transmitting uncompressed video data. It is a digital alternative to consumer analog standards, such as radio

HDMI cable

frequency (RF) coaxial cable, composite video, or VGA. HDMI digital signals are backwards compatible with DVI (same electrical definition, called Transmission-Minimized Differential Signaling, or TMDS). In both cases, the data stream is a combination of image data, audio data, and control information (for instance mute commands and color compatibility information). All this data is transferred over 4 high-speed differential pairs (requiring 12 pins in the connector because each pair has a ground pin). There are 7 additional pins in the connectors for separate communication channels. These are dedicated to handling specific consumer electronics situations (Audio Return, Digital Rights Protection, an Ethernet link to reduce cable clutter, and an interface for remote controls). The protocol does not specify a maximum length but a link loss.

DisplayPort

DisplayPort is a digital display interface standard. The specification defines a digital interconnect and data transmission for audio and video. The interface is primarily used to connect a video source to a display device such as a computer monitor (as opposed to HDMI which was originally meant for consumer entertainment systems). DisplayPort is considered more versatile than HDMI, and is able to support higher image resolutions with the same number of lanes. It also allows more flexibility with computers supporting multiple displays, which may have different resolutions.



DisplayPort resolutions:The straight lines indicate screen resolutions for given aspect ratios, the curved lines show the theoretical limit of various interconnects.

A rugged overmolded and Santoprene-jacketed Glenair cable with a USB-C connector, designed to attach to a Juggernaut tactical EUD case.

Unlike HDMI and DVI, DisplayPort runs at fixed data transmission rates and 'stuffs' the channels if the full rate is not used. The standard transmission rates for each digital pair in DisplayPort are 1.62Gb/s (Reduced Bandwidth Rate or RBR), 2.7 Gb/s (High Bandwidth Rate or HBR), 5.4 Gb/s (HBR2), 8.1 Gb/s (HBR3). Future versions will add 10, 13.5 and 20 Gb/s lanes.

USB-C

The promise of USB-C is that it can potentially carry all the popular peripheral protocols in a single package (Ethernet, USB, DisplayPort and HDMI) as well as provide a battery charging capability. USB-C is not a single-protocol connector, rather a platform that can support multiple data and power formats.

The hardware implementation consists essentially on a double USB 3.X connector, with additional discrete pins used for the connections required by HDMI and DisplayPort. The connector pin-out looks identical when flipped 180 degrees. When packaged with an orientation key, all lines can be used for signal or power transmission. The result is either a USB connector that can be plugged in "upside-down", or a display connector that is used in only one orientation.

The USB-C connector accommodates 6 differential pairs, 3 on either side (4 are shielded high-speed lanes, 2 support legacy USB 2.0 data). Interspersed among those pairs are 8 discrete pins for power and auxiliary functions. The four corner pins are signal ground pins for the SuperSpeed pair shields. The interleaving separates the high-speed data streams and improves the crosstalk performance. USB-C connectors are also compatible with Thunderbolt 3, another data transmission protocol for displays and storage devices.

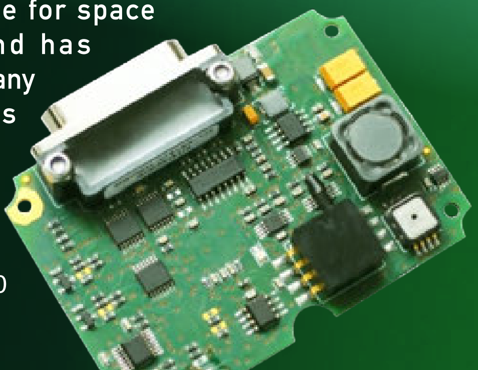
PCIe

PCIe (Peripheral Component Interconnect express) is an inside-the-box, board-level protocol. In this context, the term "interconnect" does not refer to a mechanical connector, but rather to the link between logical units. The PCIe protocol is the data bus your computer uses to exchange data between the main board and its daughter cards, such as a memory or a graphics card. The connector itself is usually a set of gold pads on the edge of the daughter card that plug directly into a socket on the mother board. There is a separate area of the connector for power supply and bus management, followed by clock and signal pairs. The size of the bus is measured in number of lanes, each lane consisting of two differential pairs (transmit and receive). The bus may not run all the pairs available mechanically, so it's possible to have an X16 bus running only at X4. The data rate in PCI protocols is expressed in transfers per second instead of bits per second. For the hardware engineer, transfer-per-second is the same as bits-per-second. This is different for software engineers, because all bits are not data, i.e. there is coding overhead. A 2.5 Gb/s link only really transmits 2.0 Gb/s because of the overhead required.

PCIe version	Introduced	Data Rate (including overhead)
1	2003	2.5Gb/s
2	2007	5Gb/s
3	2010	8Gb/s
4	2017	16Gb/s
5	2019	32Gb/s

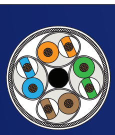
RapidIO

RapidIO is another "inside the box" data protocol. It is also used inside systems to transport data among memory and computing chips, be it on a large circuit board, from one board to another or through a backplane. The specification does not call out a connector or cable, instead it relies on electrical compliance to other specifications such as 10GBASE-KR (or 40GBase-KR). Those in turn essentially analyze the eye-diagram and set acceptable signal levels for the transmission. The implementation is often described by the number of lanes, each running maximally at 6.25Gb/s, 10.3Gb/s or 25.3Gb/s (for generation 2, 3, and 4 respectively). RapidIO deserves special attention because it is the protocol of choice for space applications and has been utilized in many military platforms as well.



GLENAIR SIGNATURE CABLE FOR HIGH-SPEED PROTOCOLS

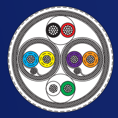
Flight-Grade 100 Ohm Ethernet Cable



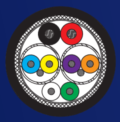
963-033 S/FTP Cable
24 and 26 AWG. S/FTP construction, foil shielded data pairs. High performance shielded cable is AS6070/5 and /6 approved.

963-003 and 963-037 S/UTP Cable
24 and 26 AWG. S/UTP construction with fluoropolymer spline. Meets FAA flammability requirements.

90 Ohm USB 3.0 Cable

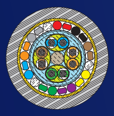


963-110 Flight-Grade Cable
High temperature, high performance, fluoropolymer aterials, shielded. High speed pairs have braid shields. -65° to +200°C.

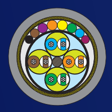


963-118 Commercial-Grade Cable
Black PVC jacket, foamed PE wire insulation. High speed pairs have foil shields. 0 to +80°C.

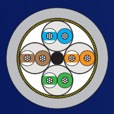
100 Ohm, HDMI, DP and SATA Cables



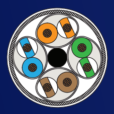
963-120 S/FTP HDMI and DP Cable
Aerospace grade 26 AWG, S/FTP construction with foil shielded data pairs. High performance cable offers three jacket material options.



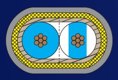
963-127 S/FTP HDMI and DP Cable
26 AWG, S/FTP construction, foil shielded data pairs and overall 36 AWG tin/copper. Jacket available in three material options.



963-122 S/FTP High-Speed Cable
4 data pair 26 AWG, S/FTP construction, foil shielded data pairs and overall 40 AWG silver plated copper braid. Three jacket material options.

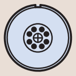
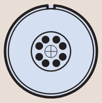
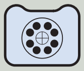
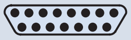
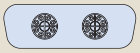
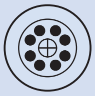
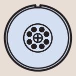
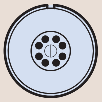
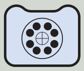
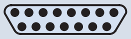
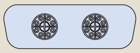
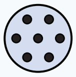
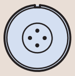
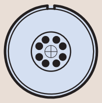
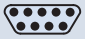
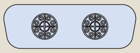
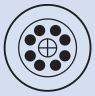
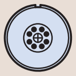
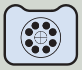
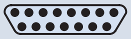
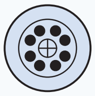
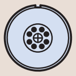
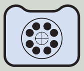
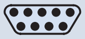
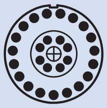
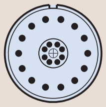
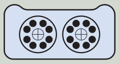
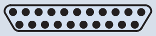
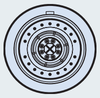
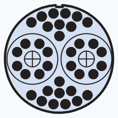
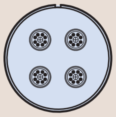
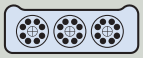
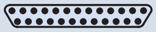
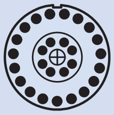
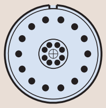
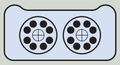
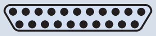
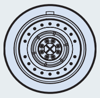
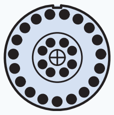
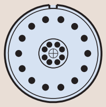
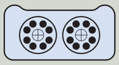
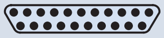
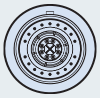


963-033 S/FTP High-Speed Cable
26 AWG, S/FTP construction, foil shielded data pairs and overall 40 AWG silver plated copper braid. Three jacket material options.



963-043 S/F Parallel Pair High-Speed Cable
26 AWG, 1 pair S/F construction

Glenair Signature High-Speed Contact / Connector Protocol Matrix

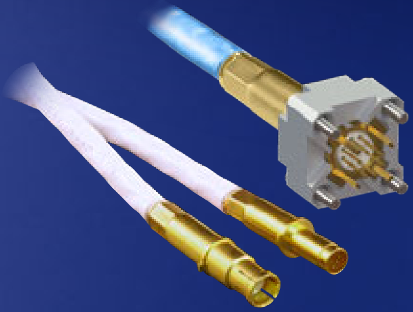
Protocol	Mil-Aero	SuperNine® 38999 Type		Series 792™ HS	MIL-DTL-83513	Series 88 SuperFly®	Series 28 HiPer-D®
	Series 806	El Ochito® / Quadrax	SpeedMaster™	El Ochito®/ Quadrax	High-Speed Micro-D	SuperFly® Datalink	SpeedMaster™
Up to: Cat 5e (1000BASE-T)	 9-11	 9G5 El Ochito - White	 11-1	 1P1 El Ochito - White	 15	 882-001/002 El Ochito - White	 2 (1 – 2 lines)
Up To: Cat 6A (10GBASE-T)	 10-1 El Ochito - White	 9G5 El Ochito - White	 11-1	 1P1 El Ochito - White	 15	 882-001/002 El Ochito - White	 2 (1 – 2 lines)
USB 2.0	 8-7	 9G5 Quadrax	 11-1 (1 – 2 lines)	 1P1 Quadrax	 9	 882-001/002 El Ochito - White (1 – 2 lines)	 2 (2 – 4 lines)
USB 3.0 (consult factory for higher versions)	 10-1 El Ochito - Blue	 9G5 El Ochito - Blue	N/A	 1P1 El Ochito - Blue	 15	 882-009/010 El Ochito - Blue	N/A
eSATA/SATA	 10-1 El Ochito - Red	 9G5 El Ochito - Red	N/A	 1P1 El Ochito - Red	 9	 882-023/024 El Ochito - Red	N/A
DVI-D Single	 14-20A El Ochito - Red	 13-14 El Ochito - Red	N/A	 2P2 El Ochito Red and White	 21	 882-019/020 El Ochito - Red	N/A
DVI-D Dual	 16-22 El Ochito - Red (2)	 19-4 El Ochito - Red (2)	N/A	 3P3 El Ochito 2-Red, 1-White	 25	Contact factory	N/A
HDMI 4k @60 FPS	 14-20A El Ochito - Red	 13-14 El Ochito - Red	N/A	 2P2 El Ochito Red and White	 21	 882-019/020 El Ochito - Red	N/A
Display Port 4k @60 FPS	 14-20A El Ochito - Red	 13-14 El Ochito - Red	N/A	 2P2 El Ochito Red and White	 21	 882-019/020 El Ochito - Red	N/A

Glenair
SIGNATURE SERIES

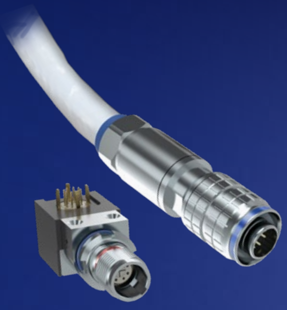
Rugged High-Speed Interconnect Solutions

Ethernet, USB, DisplayPort, HDMI, and eSATA Solutions for Mission-Critical Aerospace and Defense Applications

EL OCHITO® HIGH-SPEED OCTAXIAL CONTACTS AND CONNECTOR PACKAGING



El Ochito® high-speed octaxial contacts



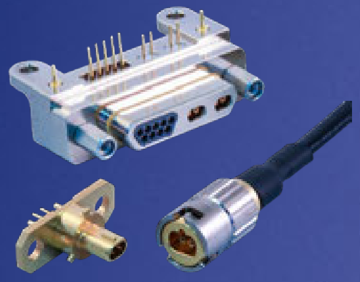
SuperFly nano miniature with El Ochito®

Series 792 micro miniature with El Ochito®

Series 806 Mil-Aero micro miniature with El Ochito®

SIGNATURE HIGH-SPEED CONNECTOR SOLUTIONS

Series 23 SuperNine® with SpeedMaster™ 10G high-speed contacts



Micro-D form-factor connector with VersaLink™ differential Twinax *plus* VersaLink™ Bridge

High-Speed Micro-D high-density SWaP solution

RUGGEDIZED ETHERNET AND USB FIELD CONNECTORS

SuperSeal™ RJ45 Ethernet and USB ruggedized field connectors

Octobyte™ industrial-strength Ethernet connectors

REPEATERS AND RE-DRIVERS

Active electronic cable components that overcome distance and signal-loss limitations in high-speed protocol applications

HIGH-SPEED
OCTAXIAL
CONTACTS

El Ochito®

High-speed octaxial contacts for Ethernet, SuperSpeed USB and multi-gigabit datalinks


Series 792 with El Ochito octaxial contacts

The shielded size #8 contact form-factor is the foundation of our next-generation octaxial contact solution, El Ochito. With the 8-contact El Ochito, any size #8 contact cavity can now support state-of-the-art high-speed protocols such as 10G Ethernet, USB 3.X, and high-resolution video displays. This high-density contact system enables seamless upgrades to higher speeds without a complete re-design of the interconnect solution. Its modular, drop-in capability allows for mixing and matching of different protocols using an identical form-factor component. Speed upgrades are immediately available in both industry standard as well as Glenair Signature connector series.

AVAILABLE SIGNATURE CONNECTOR PACKAGING INCLUDES


SuperFly
Nanominiature


806 Mil-Aero
Micro miniature


SuperNine
"Better than QPL" 38999

- **10GbE, SuperSpeed USB, and multi-gigabit shielded pairs**
- **Universal drop-in for keyed size #8 connector cavities**
- **Data-pair isolation for optimal signal integrity**
- **Crimp or threaded shield termination contact types**
- **Snap-in, rear release**
- **Environmentally sealed**
- **Aerospace-grade cable assemblies fully tested and available now**
- **50% cable / contact reduction compared to Quadrax**

HIGH-SPEED OCTAXIAL

El Ochito® Contacts

Protocols, exploded views, and circuit board transition adapters

El Ochito® White

1000BASE-T, 10GBASE-T

El Ochito® White octaxial contacts provide 10GbE in a single size #8 contact cavity (compared to two Quadrax) for 100BASE-T solutions.

El Ochito® Blue

SuperSpeed USB

Low-dielectric material. 90 ohms. El Ochito® Blue octaxial contacts provide an aerospace-grade solution for SuperSpeed USB 3.0

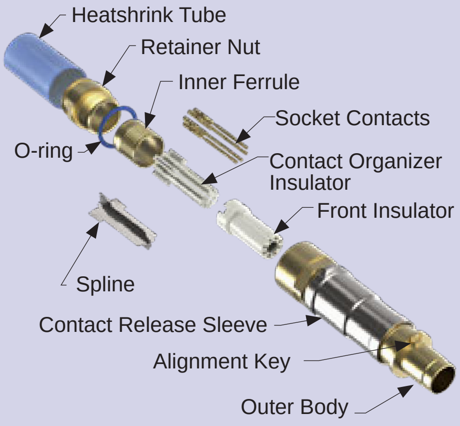
El Ochito® Red

HDMI, DisplayPort, SATA

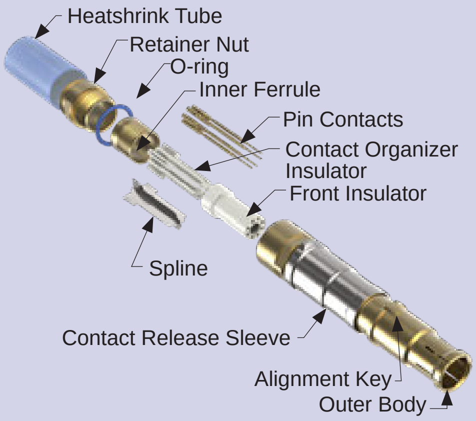
Low-dielectric material. Up to 5 Gbps. 100 ohms. El Ochito® Red octaxial contacts provide an aerospace-grade solution for multi-gigabit data rates.

El Ochito® Type II Contacts, Serviceable

24-26 AWG, Threaded Wire Shield Termination, Integral Contact Release Sleeve



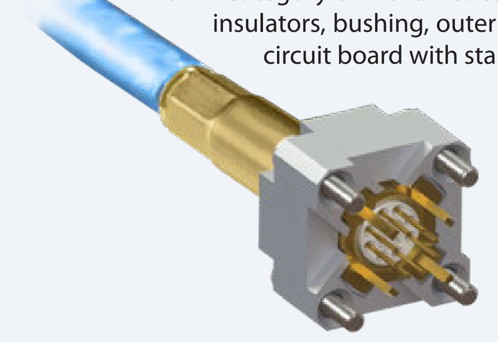
Type II Pin Contact

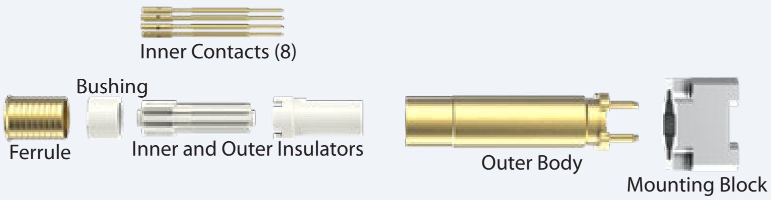


Type II Socket Contact

El Ochito Printed Circuit Board Transition Adapters

Launch controlled-impedance signals with El Ochito® transition adapters. Accepts 90 ohm USB 3.0 cable or 100 ohm Category 6A Ethernet cable. Supplied as unassembled kit with (8) inner contacts, inner and outer insulators, bushing, outer body, crimp ferrule and mounting block. Mounting block attaches easily to circuit board with standard #0-80 fasteners.





HIGH-SPEED
ULTRA
MINIATURE
I/O DATALINKS

SUPERFLY DATALINK

The Nano Miniature 10G Ethernet, USB 3.0, and DisplayPort Connector with El Ochito® Octaxial Contact Technology

High speed, harsh environment SuperFly® Datalink connectors—with shielded El Ochito® octaxial contacts for 10Gb Ethernet, SuperSpeed USB, and high datarate video display protocols—deliver outstanding signal integrity and save significant size and weight compared to Quadrax.

- Ultra-small size
- Shielded Octaxial contacts
- Up to 5 Gbps (even faster options in development)
- 10Gb Ethernet and SuperSpeed USB
- New Red insert for high-speed video, consult factory for layouts
- Environmentally protected
- Factory-terminated cables or discrete components for customer assembly

SuperFly Datalink White

1000BASE-T Ethernet
10G Ethernet

SuperFly Datalink Blue

USB 2.0
SuperSpeed USB 3.0

SuperFly Datalink Red

eSATA / SATA
DVI-D (single)
HDMI • DisplayPort

SERIES 882

SuperFly® Datalink

The high-speed nano miniature connector for harsh environments

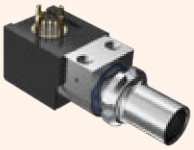
CONNECTOR CONFIGURATIONS

Quick -disconnect "push-pull" versions are ideal for tactical gear. Threaded-coupling versions are intended for aircraft and space-grade applications where secure mating is a requirement.

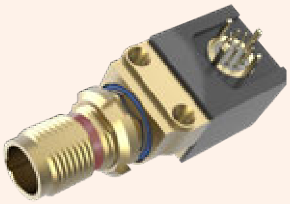
Quick Disconnect

Threaded Coupling

Straight PC Tails

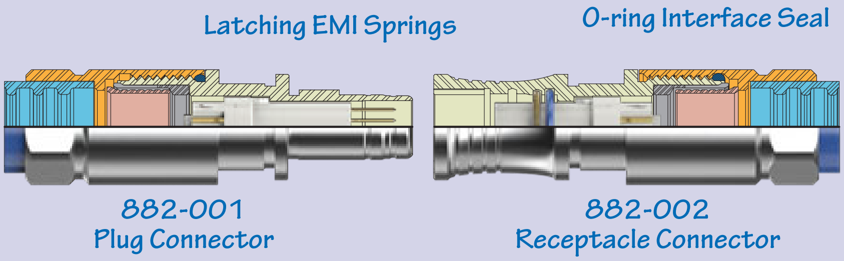


Right Angle PC Tails



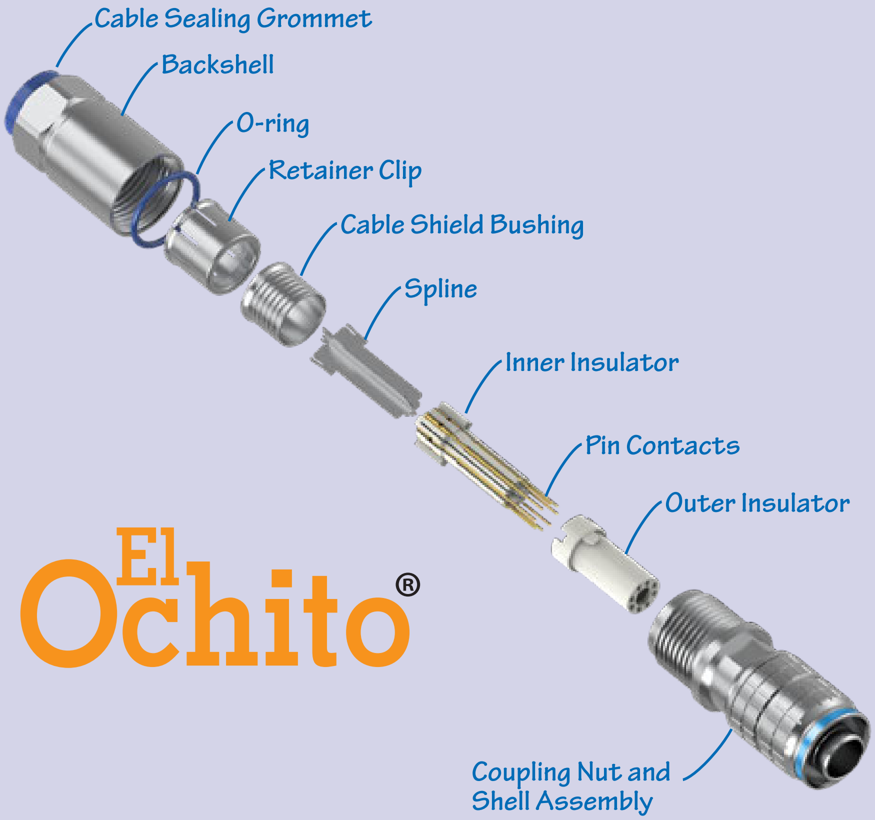
Conformal-coating-compliant panel mount connectors

Push-Pull Quick-Disconnect



Push-pull SuperFly Datalink receptacle connectors feature two canted coil springs for secure mating and excellent EMI protection. A fluorosilicone O-ring provides watertight sealing when mated.

Cable Connector



Cable connectors feature gold-plated crimp contacts, precision insulators, integral backshell, sealing grommet and machined shells.

SPEED PUZZLES

DO12"OR

f
r
i
e
n
d
s

standi

---

mis

Blood

Water

3. BLAME
4. BLAME

PAYMENT

abcdefg
hijklmnop
qrstvw
xyz

ing
s

f
r
i
e
n
d
s

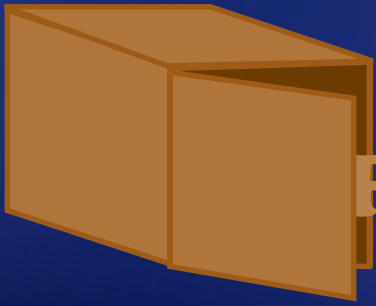
STANDS ME

0 23456

STEP
PETS
PETS

D
N
ADAM

Roger



Roger

m ce
m ce
m ce

6s4a2f9e7t5y8

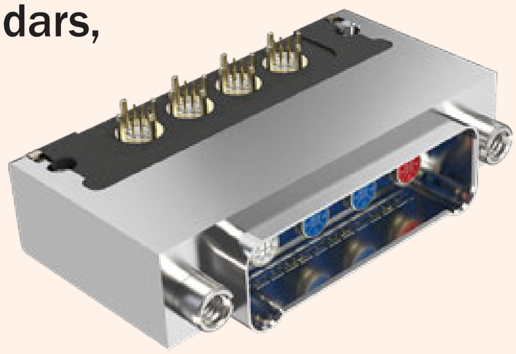
go to www.glenair.com/qwikconnect for answers

HIGH-SPEED RACK-AND-PANEL CONNECTOR WITH EL OCHITO® OCTAXIAL CONTACTS

SERIES 792™
SEVEN NINETY-TWO

The next-generation micro miniature rectangular connector with El Ochito contacts for high-speed aerospace applications

The Series 792 connector brings high-speed data-rate performance to the Glenair Series 79 rectangular family. Size 8 cavities accept standard Quadrax or El Ochito® shielded octaxial contacts making it a perfect choice for radars, weapons systems, mission computers and displays, communications gear, and more.



El Ochito®

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

HIGH-SPEED

Series 792

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

Save Size and Weight with Series 792 Connectors

The Multi-Port Multi-Protocol Connector with El Ochito® Contacts

About The Series 792

The Series 792 brings high-speed board-to-wire capability to the Glenair Series 79 family of ultraminiature rectangular connectors. Developed in collaboration with NASA / JPL, the Series 792 is intended for avionics and space equipment exposed to high-vibration and hostile environments.

The 792 supports quadrax contacts for ARINC 664 and El Ochito® octaxial contacts for 10Gb Ethernet, USB 3.0, HDMI and other protocols.

Machined aluminum alloy shells feature dual lobes for polarization. Pin contacts are recessed to prevent scooping damage. Crimp contacts conform to M39029 requirements and are rear release.

An optional ground spring in the receptacle minimizes EMI. Fluorosilicone face seals and wire grommets protect from 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 cover for added EMI protection.

Metal EMI Panel Spring

A gold-plated panel spring option is available for Series 792 connectors with panel mount flanges. This spring provides improved electrical bonding.

Twinax, Quadrax and **El Ochito**®

Connectors are available in three configurations: twinax for a single high-speed wire pair, quadrax for two data pairs, and El Ochito® for four data pairs.

PCB Connectors

Series 792 PCB connectors have straight or right angle PC tails. Contacts are non-removable and are epoxy sealed. Right-angle connectors eliminate the need for board-to-panel I/O jumpers.

El Ochito®
White

GbE
10GbE

El Ochito®
Blue

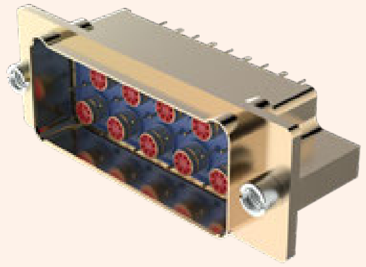
USB 3.0

El Ochito®
Red

HDMI, SATA,
DisplayPort

El Ochito® Contacts

Series 792 connectors feature El Ochito® octaxial contacts for Ethernet, SuperSpeed USB, HDMI, DisplayPort, SATA and other multi-gigabit protocols. Multiple protocols can be supported in a single multi-port connector.



Up to 9 data ports

The Series 792 Size F with nine ports is the largest connector in the series and is the only two row version. Sizes A – E, with one to five ports, are single row.

Panel Mount

Panel mount connectors have an O-ring and threaded mounting holes for easy installation. Suitable for blind mate modules, the Series 792 is available with guide pins and float mounts.

Cable Connectors

Quadrax and El Ochito® contacts snap into Series 792 cable connectors and are easily removed with a standard plastic tool. Alignment keys provide correct orientation.

NEXT-GENERATION
HIGH-SPEED
MICRO
MINIATURE
CONNECTORS

SERIES 806 MIL-AERO

806 Mil-Aero: Advanced Performance, Reduced Size and Weight Connector Series IAW MIL-DTL-38999

Series 806 meets key performance benchmarks for harsh vibration, shock, and environmental settings—as well as high-altitude, unpressurized aircraft zones with aggressive voltage ratings and altitude immersion standards.

Series 806 with four 10GbE El Ochito channels

SERIES 806 MIL-AERO CONNECTORS WITH EL OCHITO® CONTACTS

White
GbE
10GbE

Blue
USB 3.0

Red
HDMI, SATA,
DisplayPort

- **10GbE, SuperSpeed USB 3.0, HDMI and DisplayPort**
- **Crimp shield termination and threaded contact types**
- **Snap-in, rear release**
- **Environmentally protected**

El Ochito®

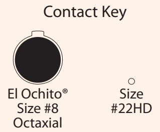
- **Next-generation micro miniature aerospace-grade circular connector**
- **Upgraded environmental, electrical and mechanical performance IAW MIL-DTL-38999 Series III**
- **Integrated anti-decoupling technology**
- **High-Speed El Ochito® and hybrid #22HD contact arrangements**

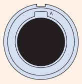
HIGH-SPEED

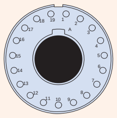
Series 806 Mil-Aero Micro Miniature Circular Connectors

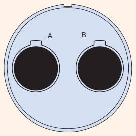
with El Ochito® octaxial contacts

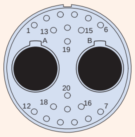
Series 806 with El Ochito® contact arrangements



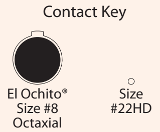


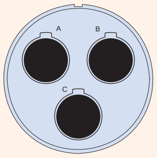


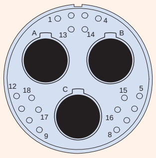


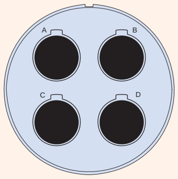


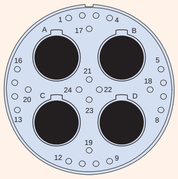
Insert Arrangement	10-1	14-20A		16-2	16-22	
No. of Contacts	1x #8	1x #8	19x #22HD	2x #8	2x #8	20x #22HD



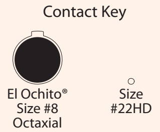


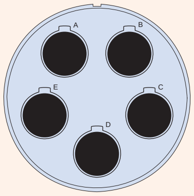


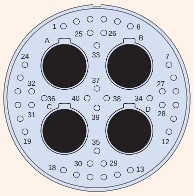


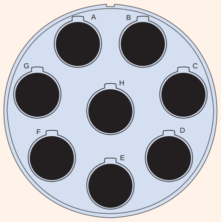


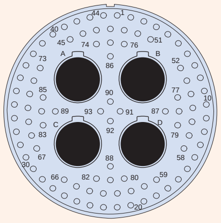
Insert Arrangement	18-3	18-21		20-4	20-28	
No. of Contacts	3x #8	3x #8	18x #22HD	4x #8	4x #8	24x #22HD











Insert Arrangement	22-5	22-44		24-8	24-97	
No. of Contacts	5x #8	4x #8	40x #22HD	8x #8	4x #8	93x #22HD

RECOMMENDED BACKSHELL

627-261

Swing-Arm 3-in-1 strain relief with cable bushing

SAVE SIZE AND WEIGHT WITH SERIES 806 MIL-AERO 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

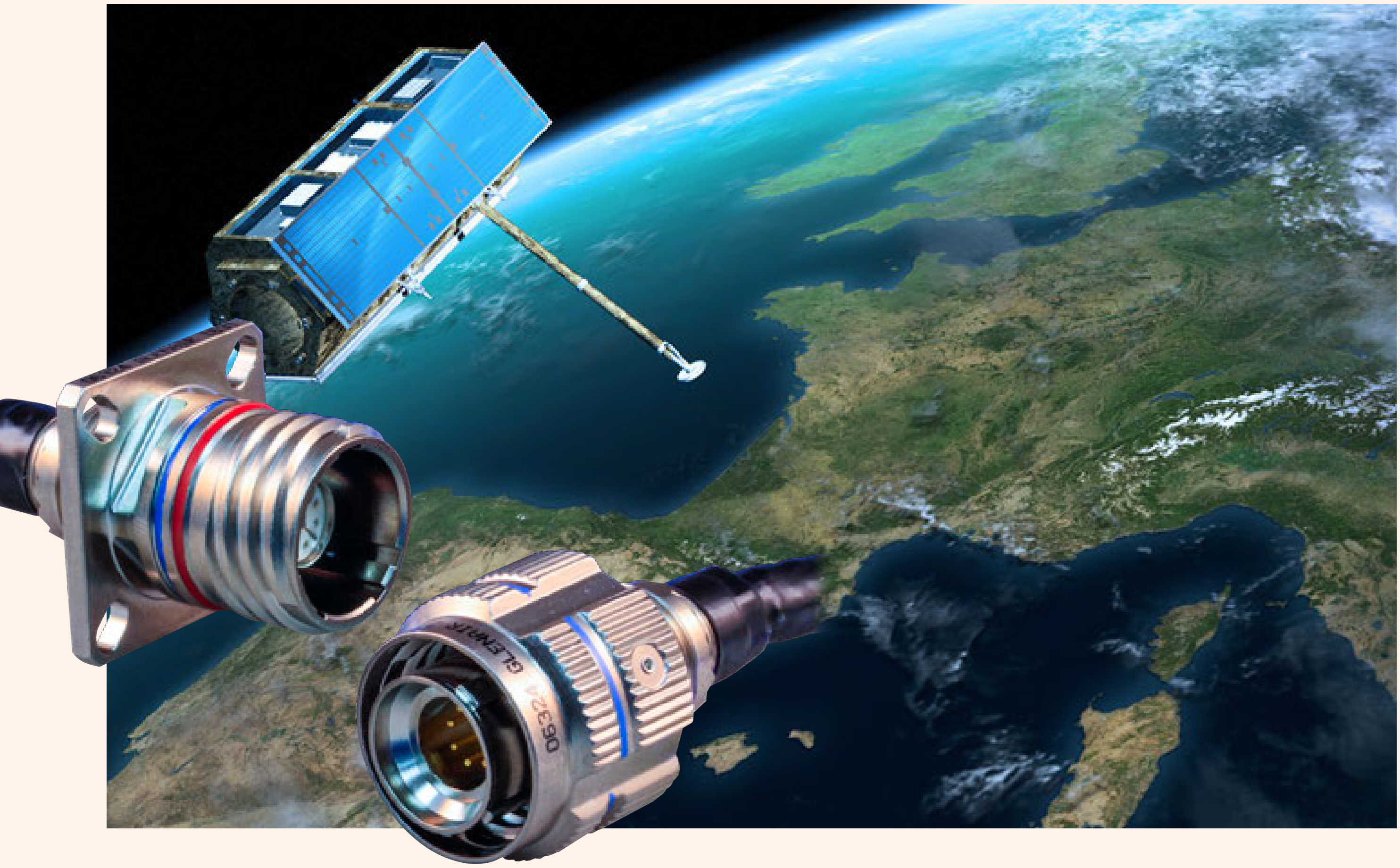
FEATURES

- **Triple-start stub ACME mating thread**
- **El Ochito® Octaxial and hybrid High density #22HD arrangements for reduced size / weight and high-speed performance**
- **Aerospace-grade materials, construction, and performance**
- **Vibration, shock, altitude immersion IAW MIL-DTL-38999 Series III**

10G HIGH-SPEED CONTACT MODULES FOR GLENAIR SIGNATURE SERIES CONNECTORS

SPEEDMASTER™

High-speed 10G connection system for Glenair SuperNine, Mighty Mouse, and HiPer-D connectors



SpeedMaster™ is a dedicated size #22D crimp-contact module and insert package for SuperNine®, Mighty Mouse, and HiPer-D connectors. Optimized for high-speed Cat 6A Ethernet, the SpeedMaster™ 10G system offers industry-leading NEXT, return loss and insertion loss performance

- **Utilizes aerospace industry standard #22D contacts, tools, and widely available Ethernet flight cable**
- **Significant weight reduction compared to Quadrax solutions (reduces cable requirement by half)**

SpeedMaster Mighty Mouse Locking Push/Pull Connectors

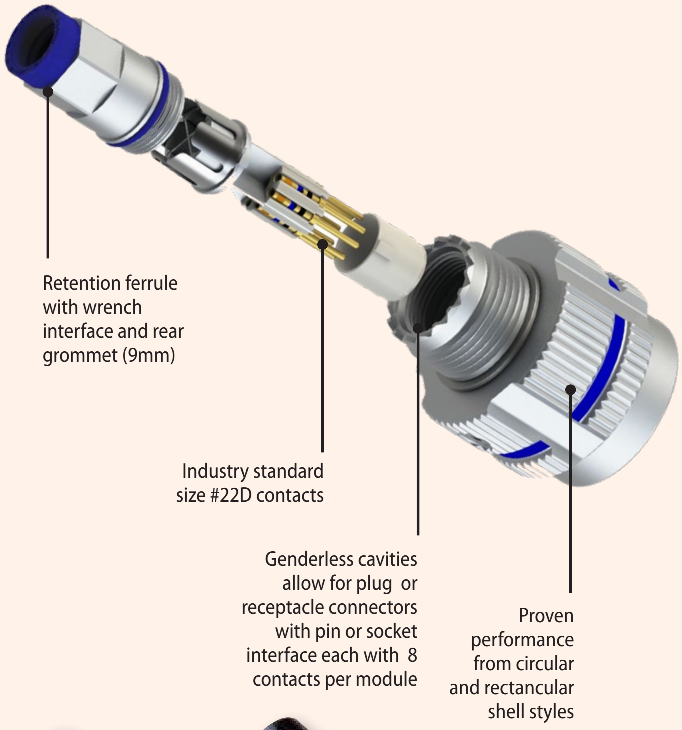
SpeedMaster HiPer-D Rectangular (M24308 intermountable)

SpeedMaster SuperNine “better than QPL” connectors

SpeedMaster™ High-Speed 10G Connection System

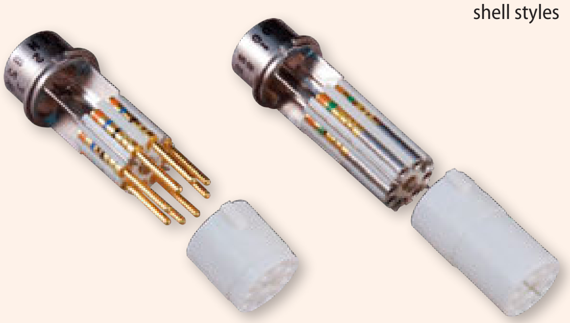
for Glenair SuperNine, Mighty Mouse, and HiPer-D connectors

SPEEDMASTER 10G NEXT-GENERATION HIGH-SPEED CONNECTION SYSTEM



The SpeedMaster Difference

SpeedMaster, the high-speed multi-contact solution for the Mighty Mouse, HiPer-D and SuperNine 38999 type family of connectors. Each SpeedMaster module consists of 4 pairs of pins or sockets incorporating industry standard size 22D contacts to provide 10G performance. Each module is individually shielded within the shell, and retained in place with a threaded ferrule. Additionally, module cavities are genderless allowing pin or socket interface for plugs or receptacles. Glenair offers these SpeedMaster contacts in 3 connector packages, including our small form factor Mighty Mouse Series 824 Locking Push/Pull, HiPer-D (M24308) hi-performance rectangular D-Sub, and our 38999 type "better than QPL" connectors allowing you to adapt and fit your application needs. These features result in a two fold benefit. An easily removable and repairable, shielded high performance contact packaged within robust industry standard connectors, helping to reduce network downtime and providing a connectorized solution to improve the overall network function and performance. Meet the demand for the next generation Cat 6A networks with SpeedMaster, the next generation contact system from Glenair.



SpeedMaster 10G modular inserts are available for Series 23 SuperNine – 38999, Series 80 Mighty Mouse – Locking Push / Pull and Series 28 HiPer-D – M24308 rectangular D-Sub connectors

The SpeedMaster 10G is optimized for high-speed Ethernet performance and incorporates standard M39029 #22D contacts isolated for superior NEXT, return loss and insertion loss performance

***SpeedMaster Glass-Sealed Hermetic:* Fully qualified to MIL-DTL-38999 Series III environmental and mechanical specifications. 10^{-7} Helium leak rate. Outstanding high-speed performance. Bulkhead feed-thru shown.**

SpeedMaster™ High-Speed Cable

Cable P/N	Cabel Category	Cable Construction	Wire Gage	Cable Dia.	Assembly Instruction
963-003-24	Cat 6A	SF/UTP	24	.280	AI85082
963-003-26	Cat 6A	SF/UTP	26	.220	
963-037	Cat 6A	SF/UTP	24	.260	
963-033-24	CAT 6A	S/FTP	24	.260	
933-033-26	CAT 6A	S/FTP	26	.220	

VersaLink™

Ultra Miniature Micro-D Connectors with High-Speed VersaLink Contact Technology

Innovative differential Twinax contact technology in ruggedized, high-density mil-spec connector packaging

High-speed serial data protocols (USB 3.1 Gen2, USB-C, SATA, PCIe, DisplayPort, and HDMI) all have transmission rates in the 10Gb/s+ range for each data pair. In order to provide truly high-speed signal integrity for these bandwidth-dependent protocols, Glenair has invented a new contact technology called VersaLink™ which delivers outstanding impedance matching and cross-talk isolation at both the cable-to-connector interface, as well as between connector and board. VersaLink is a highly-engineered differential Twinax contact module that may be packaged in a wide range of both circular and rectangular connector formats such as the MIL-DTL-83513 Micro-D. This high-density package solution provides mating reliability, ruggedness, signal integrity, and deployment simplicity.

Data-intensive servers, computers and peripheral devices in mission-critical applications require a new generation of shielded contact technology and tried-and-true connector package performance. Both are exquisitely realized in the VersaLink Micro-D.

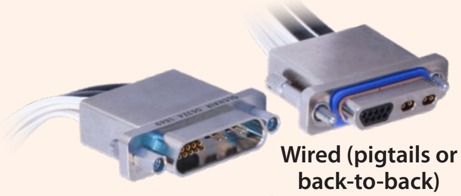
- **VersaLink: shielded differential Twinax interconnect solution**
- **Signature Glenair design intermountable in standard Micro-D footprints**
- **Higher speed and density than mil-spec style Twinax solutions**
- **Individually shielded pairs result in virtually zero cross talk**
- **Hybrid arrangements with VersaLink contact modules and standard Micro-D inserts for signal and power**

HIGH-SPEED

VersaLink™ Micro-D

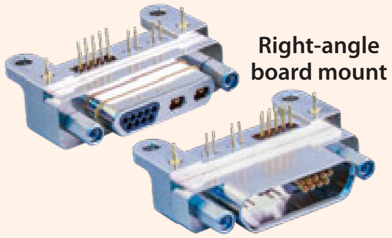
Military-standard Micro-D connectors with “zero crosstalk” VersaLink™ Twinax contact modules

CONNECTOR CONFIGURATIONS



Wired (pigtails or back-to-back)

Straight board mount



Right-angle board mount

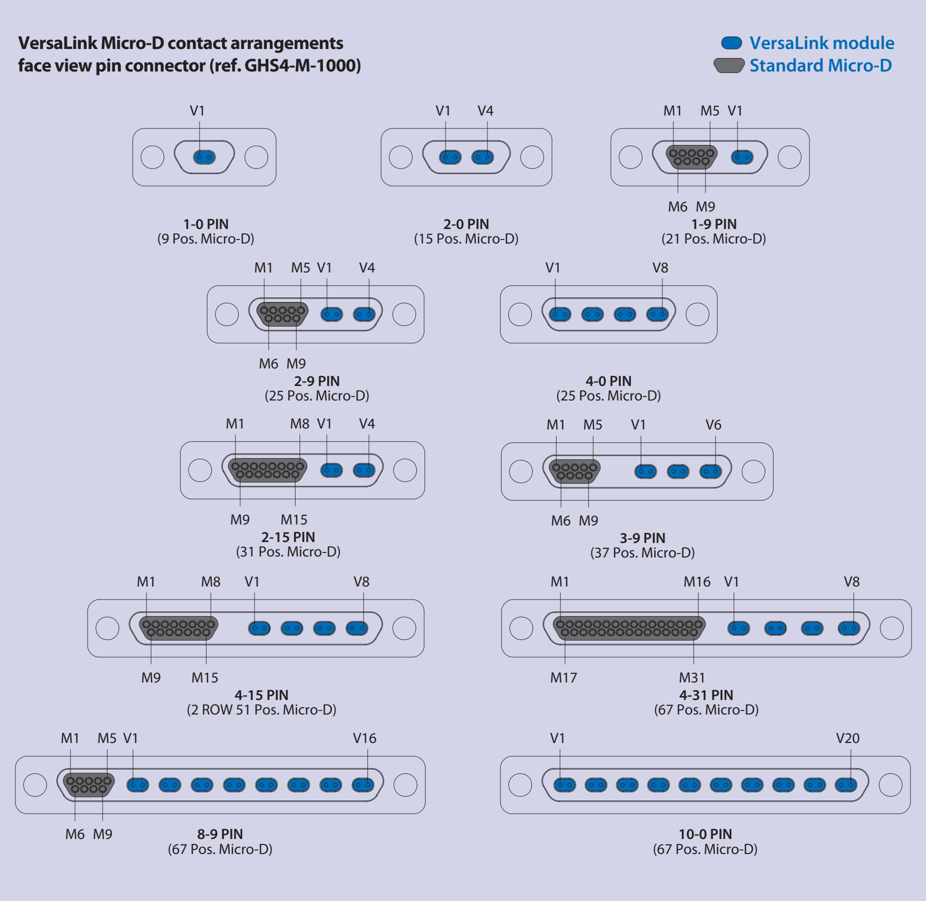
EMI SHIELDING AND ENVIRONMENTAL SEALING

Plug connectors feature a gold-plated stainless steel ground spring for EMI protection, and a silicone gasket for environmental sealing.

SUPPORTED HIGH-SPEED PROTOCOLS AND APPLICATIONS

Networking Protocols	Peripheral and Display Protocols	
10Gb Ethernet 40Gb Ethernet	**DVI** (Digital Visual Interface) **HDMI 2.0** (High-Definition Multimedia Interface) **DisplayPort 1.2** **SATA 3** (Serial AT Attachment)	**USB 3.0** (Universal Serial Bus) **USB 3.1 Type C** (Universal Serial Bus) **USB 3.2** (Universal Serial Bus) **PCIe 3** (Peripheral Component Interconnect)

CONTACT ARRANGEMENTS



Coming Soon:
VersaLink high-speed differential twinax for Series 806 Mil-Aero—innovative micro-miniature crimp-contact terminatable aerospace-grade circular with performance IAW MIL-DTL-38999

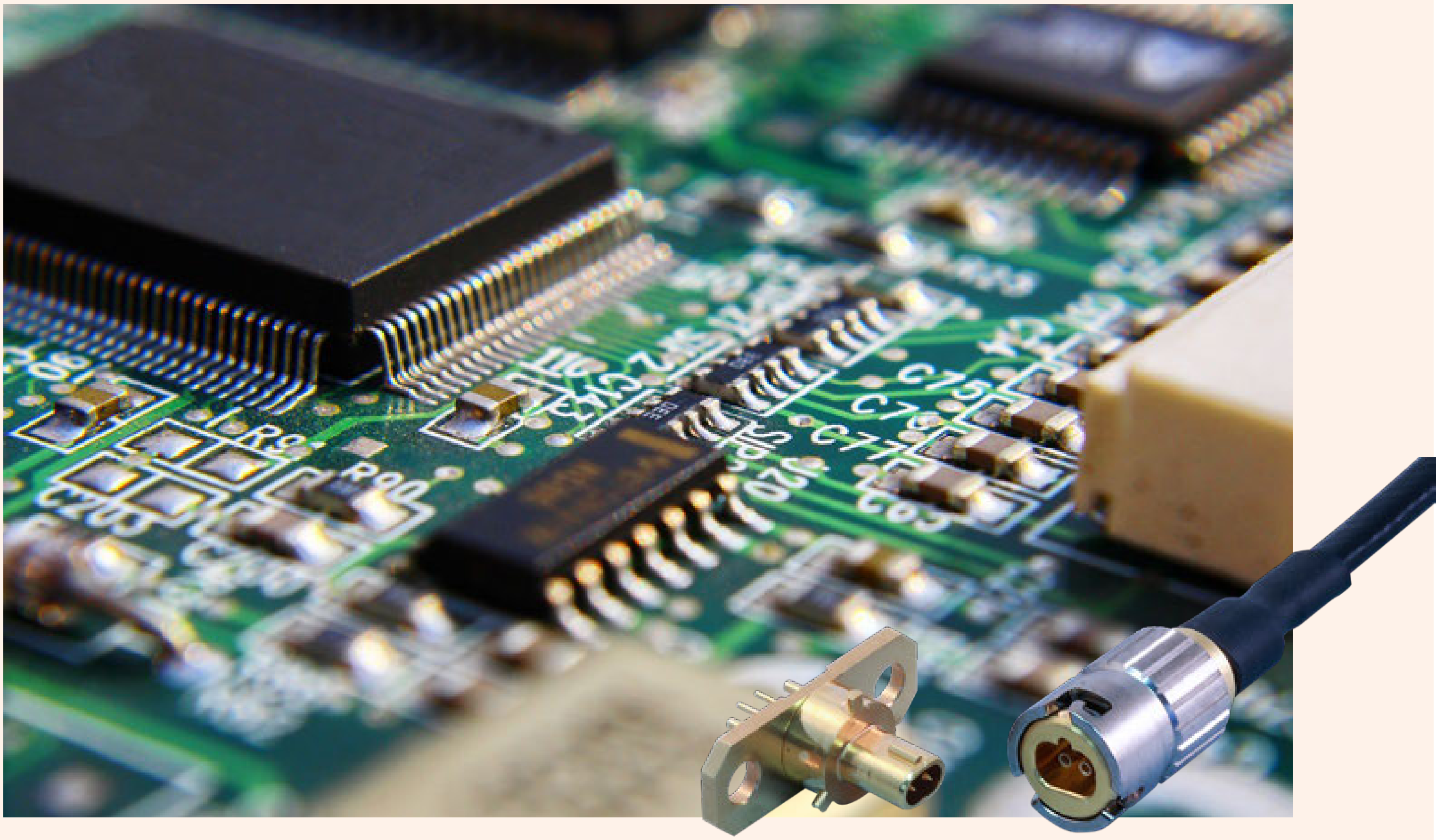
VERSALINK MICRO-D PERFORMANCE

Current Rating: 3 Amp (Micro-D pins)
DWV (Contact M): 600 VAC Sea Level
Insulation Resistance (Contact M): 5000 Megohms Minimum
Contact Resistance (Contact M): 8 Milliohms Maximum
Low Level Contact Resistance: 32 Milliohms Maximum
Operating Temperature: -55°C To 125°C
Mating Force (Contact M): (10 Ounces) X (# Of Contacts)
Mating Force (Contact V): (5 Ounces) X (# Of Contacts)

HIGH-SPEED
VERSALINK™
DIFFERENTIAL
TWINAX BYPASS
JUMPERS

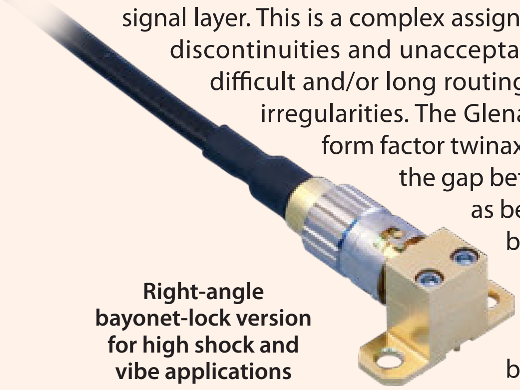
VersaLink™
BRIDGE

VersaLink Bridge: 100 Ohm connectors and jumpers for high-speed board applications



VersaLink Bridge: bypass high-loss board traces with a small, low insertion-loss and low signal-latency point-to-point Twinax jumper

High-speed data transmission from one PCB to another, from one side of a backplane to another, or even from one side of a complex embedded system to another, is frequently accomplished by routing high-speed traces on a dedicated high-speed signal layer. This is a complex assignment—fraught with potential for impedance discontinuities and unacceptable insertion loss—as traces must navigate difficult and/or long routing paths around via columns and other board irregularities. The Glenair VersaLink Bridge is a high-density, micro-form factor twinax connector / jumper assembly used to bridge the gap between point A and point B on the board (such as between two SML integrated circuit chips) with better signal integrity than native board traces can ever deliver. VersaLink Bridge is equally capable of dramatically reducing insertion loss and signal latencies for data traffic between an ASIC and the I/O.



Right-angle bayonet-lock version for high shock and vibe applications

VERSALINK BRIDGE FEATURES

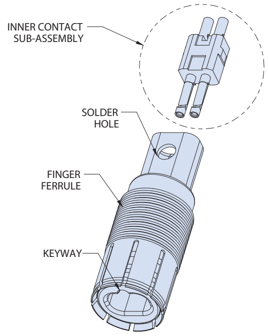
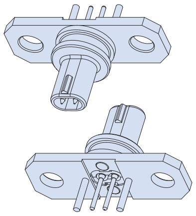
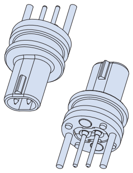
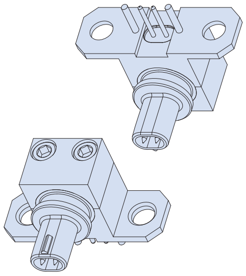
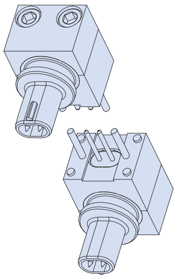
- Small footprint, high-density solution
- Versatile solder-mount or screw-mount board termination
- 100 Ohm differential Twinax
- Push-pull mating or bayonet-lock for high vibration and shock applications
- Keyed polarization prevents mis-mating
- Low insertion loss and low signal latencies for high datarate board transmissions

HIGH-SPEED

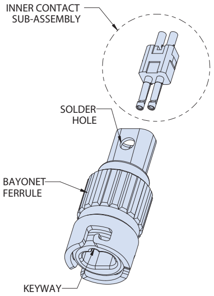
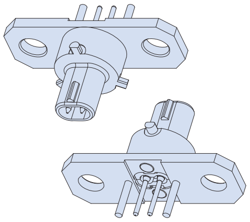
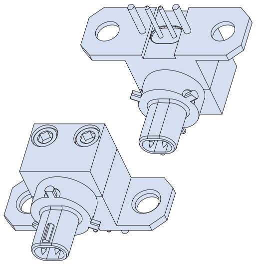
VersaLink™ Bridge

Differential Twinax “bypass” connector and jumper assemblies

AVAILABLE CONFIGURATIONS: QUICK-DISCONNECT

				
Quick-disconnect plug	QDC Jack board pin straight screw mount	QDC Jack board pin straight solder mount	QDC Jack board pin right-angle screw mount	QDC Jack board pin right-angle solder mount

AVAILABLE CONFIGURATIONS: BAYONET-LOCK

		
Bayonet-lock plug	Bayonet-lock Jack board pin straight screw mount	Bayonet-lock Jack board pin straight screw mount

Recommended Cable for Plug Connectors

Cable P/N	Cable Construction	Wire Gauge	Impedance	Max. Overall Size
963-043-26	Twinax In-Line	26	100 Ω	.121" X .076"

MATERIALS AND FINISHES

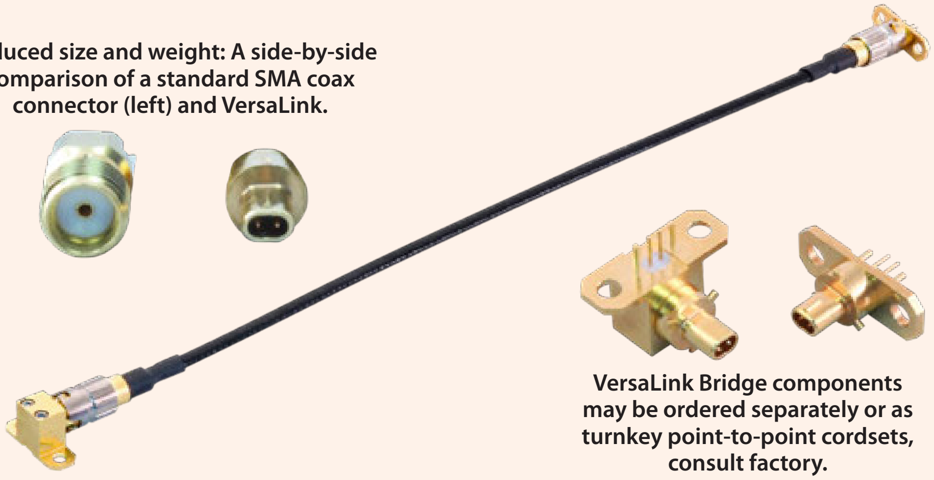
Contacts: Copper alloy / gold
Insulators: Superior rigid dielectric
Body: Copper alloy / gold
Ferrules (plugs): Copper alloy / electroless nickel
Spring (plugs): Music wire

ELECTRICAL PARAMETERS

(for Board Connectors)

Impedance: 100 Ohms
DWV: 500 RMS
IR: 5000 Megaohms min. at 200 VDC

Reduced size and weight: A side-by-side comparison of a standard SMA coax connector (left) and VersaLink.

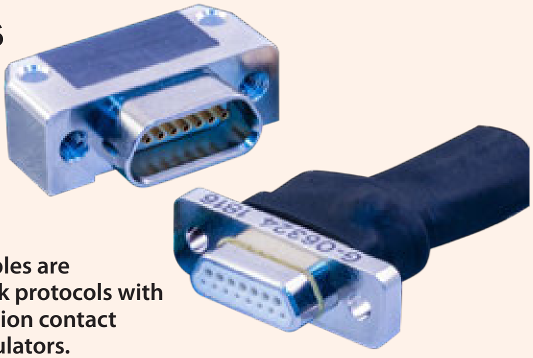


VersaLink Bridge components may be ordered separately or as turnkey point-to-point cordsets, consult factory.

MICRO–D
High-Speed

High-Speed Micro-D: Smallest and Lightest Aerospace-Grade High-Speed Connector Solution

The High-Speed Micro-D is a 1 Amp pre-wired cable and PCB solution with 10+ Gb/sec. performance per differential pair. Auxiliary EMC ground springs on plug and integral contact separation architecture ensures data integrity and low attenuation performance.



High-Speed Micro-D connectors and cables are optimized for high-speed digital datalink protocols with machined-shell packaging, low attenuation contact spacing, and ultra low PPS dielectric insulators.

- **Pre-wired factory cordsets and PCB connectors**
- **Unique contact isolation and spacing for optimal high-speed performance**
- **Standard layouts support maximum #28 AWG wire**
- **Ultra-low dielectric material combined with optimized contact size and spacing**
- **Precision-machined shells with gold or nickel plating**
- **Hybrid contact solutions available with 3 amp and 1 amp TwistPin contacts (perfect for USB 3.0 SuperSpeed applications)**

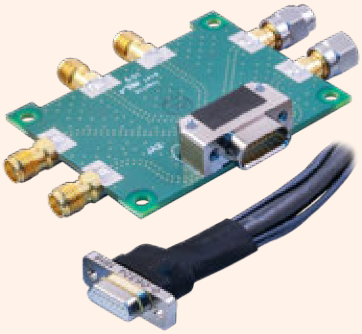
HIGH-SPEED

Micro-D

The miniature high-speed connector with mil-spec pedigree connector and contact packaging

SUPPORTED HIGH-SPEED PROTOCOLS

Shell Sizes and contact arrangements optimized for today's popular high-speed protocols



21	21	25	21
Display Port 1.2	HDMI 2.0	DVI-D Dual	DVI-D Single
9	15	9	15
eSATA/SATA 3	USB 3.0	USB 2.0	Up To: Cat 6A (10GBASE-T)

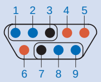
Micro-D High-Speed configurations include wired assemblies and straight or 90° PCB-mount connectors. Insert arrangements feature 1 Amp Nanominiature TwistPin contacts. Hybrid 1Amp/3Amp arrangements for USB 3.0 SuperSpeed are also available. All designs have been tested for today's popular high-speed protocols.

EMI SHIELDING AND ENVIRONMENTAL SEALING

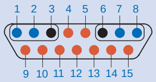
Plug connectors feature a gold-plated stainless steel ground spring for EMI protection, and a silicone gasket for environmental sealing.

High-Speed Micro-D contact arrangements face view pin connector

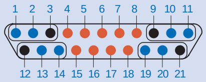
- ● high-speed signal pair
- ● signal-pair drain wire
- ● low-speed signal or power contacts



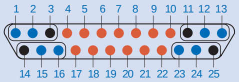
9 pin
(2 high-speed signal pairs)



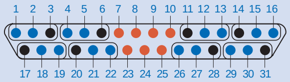
15 pin
(2 high-speed signal pairs)



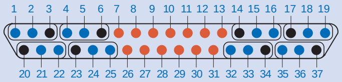
21 pin
(4 high-speed signal pairs)



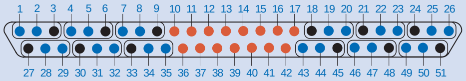
25 pin
(4 high-speed signal pairs)



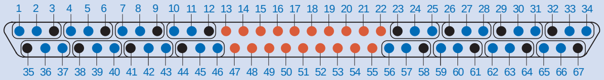
31 pin
(8 high-speed signal pairs)



37 pin
(8 high-speed signal pairs)



51 pin (special 2 row)
(12 high-speed signal pairs)



67 pin
(16 high-speed signal pairs)

MATERIALS AND FINISHES

Connector Shell: Aluminum Alloy 6061
Insulator: Polyphenylene Sulfide (PPS)
Flange Seal: Fluorosilicone Rubber, Blue
Pin Contact: Copper Alloy, Gold over Nickel Plating
Socket Contact: Copper Alloy, Gold over Nickel Plating
Ground Spring: Stainless Steel, Gold Plating
Hardware: 300 Series Stainless Steel, Passivated
Epoxy Resin Hysol EE4215 and Stycast 2850FT/Catalyst 11

PERFORMANCE SPECIFICATIONS

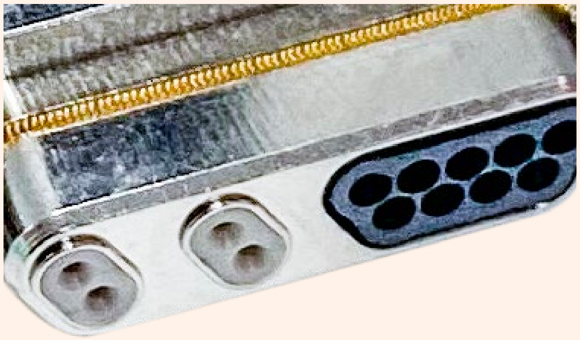
Current Rating: 1 Amp*
DWV: 600 VAC Sea Level
Insulation Resistance: 5000 Megohms Minimum (500 VDC)
Contact Resistance: 80 Milliohms Maximum
Operating Temperature: -55°C To 125°C
Mating Force: (7 Ounces) X (# of 1 Amp Contacts)**
Durability: 500 Mating Cycles

*Contact factory for custom configurations supporting up to 3 Amps.

**Add (10 Ounces) X (# of 3 Amp Contacts) for mating force for configurations with 3 Amp contacts

GMMD: The modular Micro-D differential twinax high-speed solution. Hybrid design accommodates both high data-rate and standard low-speed signal requirements in a single connector package.

Signature Nano TwistPin differential twinax contact modules plus Micro-D TwistPin signal contact inserts incorporated into high-reliability Micro-D connector shells for easy integration in mission-critical high data-rate applications



Signature Twinax contact modules are fully shielded for outstanding cross-talk isolation and signal integrity. Standard Micro-D TwistPin contact modules deliver reliable performance IAW MIL-PRF-83513

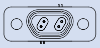
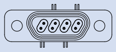
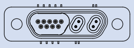
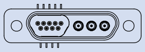
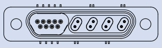
- **Low crosstalk, high bandwidth twinax modules for 10Gb/s performance**
- **Cable and 90° PCB configurations for matched 100 Ohm differential impedance performance from I/O to board**
- **SMT receptacles for easy PCB mounting and optimum high-speed performance**
- **Hybrid layouts include twinax, 50 and 75Ω coax, mixed signal and power**
- **Utilizes TwistPin contacts for excellent resistance to shock and vibration and low contact-resistance**
- **Standard shell sizes and hardware**

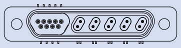
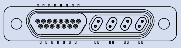
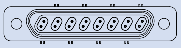
GMMD DIFFERENTIAL TWINAX

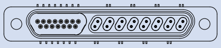
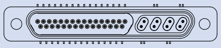
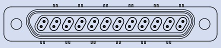
Modular High-Speed Micro-D

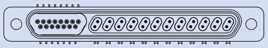
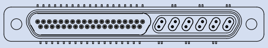
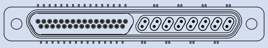
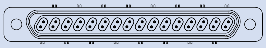
Contact arrangements and product specifications

GMMD Contact Arrangements

					
Contact Arrangement	**2T**	**4T**	**2T9**	**3C9**	**4T9**
Shell Size	9	15	21	25	31
No. / type of contacts	2 Twinax	4 Twinax	2 Twinax, 9 #24	3 Coax, 9 #24	4 Twinax, 9#24
Example applications	SpFi	10GbE, 2xSATA, SpW, 2xSpFi	USB 3.1, SATA + power		HDMI, DP, DVI, 10GbE + power

			
Contact Arrangement	**5T9**	**4T15**	**8T**
Shell Size	37	37	37
No. / type of contacts	5 Twinax, 9 #24	4 Twinax, 15 #24	8 Twinax
Example applications	DP incl. Aux channels		2x10GbE

			
Contact Arrangement	**8T15**	**4T31**	**12T**
Shell Size	51-2	51-2	51-2
No. / type of contacts	8 Twinax, 15 #24	4 Twinax, 31 #24	12 Twinax
Example applications	DP or HDMI + USB 3.1, dual DVI		

				
Contact Arrangement	**12T15**	**6T37**	**8T31**	**16T**
Shell Size	67	67	67	67
No. / type of contacts	12 Twinax, 15 #24	6 Twinax, 37 #24	8 Twinax, 31 #24	16 Twinax
Example applications				4x10GbE

Example contact arrangements shown. Others available, please consult factory for details.

GMMD Modular High-Speed Micro-D Standard Materials and Finishes

Connector Shell, Metal	**Aluminum Alloy 6061 IAW SAE AMS-QQ-A-250/11:** Plating code 2: electroless nickel IAW ASTM B733 / Plating code 5: gold plated IAW ASTM B488 over electroless nickel IAW ASTM B733-90. / Plating code 6: chem film IAW MIL-C-5541 Class 3 **Stainless Steel, 300 Series:** Plating Code 3: Passivated IAW SAE AMS 2700
#24 Insulator and organizer tray, Terminal Block, PCB (LCP & PPS)	Liquid crystal polymer, 30% glass-filled or polyphenyl sulfide
Interfacial Seal (where applicable)	Fluorosilicone rubber IAW MIL-R-25988
Conductive Potting	Silver-loaded epoxy
EMI Spring	Gold-plated stainless steel
#24 Pin Contact (TwistPin)	Beryllium copper, gold plated IAW ASTM B 488 Type II Class 1.27 (50 Min minimum) Code C, over nickel underplate IAW SAE AMS-QQ-N-290, class 2, (50-150 µin).
#24 Socket Contact	Phos bronze IAW ASTM 139 gold plated IAW ASTM B 488 Type II Class 1.27 (50 Min minimum) Code C, over nickel underplate IAW SAE-AMS-QQ-N-290, Class 2, (50-150 µin).
Twinax #30 pin contacts	Spring Temper Gold alloy, unplated, per ASTM B477 and ASTM B541
Twinax #30 socket contacts	Gold alloy, unplated, per ASTM B477 and ASTM B541
Twinax Insert	unfilled PEEK
Encapsulant (Potting)	Epoxy resin, hysol EE4215/HD3561
Jackscrews, Jackposts, Float Mounts	Stainless steel, 300 series, passivated IAW SAE AMS 2700
Twinax wire	AWG 28 or 30 twisted pair, PTFE dielectric, silver plated copper conductors, SPC braid, fluoropolymer jacket

ETHERNET-READY
HIGH-SPEED
INSUSTRIAL-
STRENGTH

Octobyte™

The faster ruggedized 4/8 pole interconnect system for Ethernet data applications

Glenair precision machined, Super ITS - ITH Octobyte connectors with 4- and 8-pole contacts are available with fully dedicated Ethernet protocol or power / signal combo versions where a mix of signal-power and Ethernet is required. RoHS compliant, IP67 (IP68 on request) exceeds performance expectations typical in harsh environmental applications found throughout military defense, rail, and harsh industrial markets.

Shielded Octobyte contacts are vibration resistant and support Cat 5 thru Cat 7A Ethernet, MVB-WTB, RG58 and Coax cables. Connectors feature a reverse-bayonet, locking three pin quarter turn locking coupler. Octobyte contacts are rigorously tested making them the best solution for harsh environment applications where signal reliability is a must.

Tested for compliance IAW EN50173-1 standards for CAT5E and CAT7.
Proven performance in numerous rail applications (consult factory for references)

- **Industrial/military power and signal applications such as command and control shelters**
- **Ruggedized for high-reliability harsh environment performance**
- **High-speed interconnect solution for audio, video, and digital displays**
- **Qualified for use in safety systems, sensors, detection devices, and control panels**
- **Tested in accordance with:**
  ISO F0 STP: CAT 7A
  EN50173-1 F600-STP: CAT 7
  EN50173-1 D STP: CAT 5E

OCTOBYTE™

The faster ruggedized Ethernet interconnect solution

OCTOBYTE CONTACTS FOR ETHERNET CAT 5 · CAT 6 · CAT 7 · COAX · MVB-WBT


CAT 5 · CAT 5E · CAT 6 · CAT 6A


RG58


CAT 6A · CAT 7 · CAT 7A


MVB - WTB

SUPER ITS - ITH CONNECTORS FOR OCTOBYTE CONTACTS

Reverse bayonet-lock connectors

Rugged environmental performance — the perfect Octobyte packaging solution

- **Rugged MIL-DTL-5015 type design with fast reverse bayonet coupling**
- **Rigid dielectric inserts with contact retention clips**
- **Crimp contact termination**
- **Positive lock technology provides reliable vibration and shock resistance**
- **Proven performance in even the most rugged applications**
- **Conforms to the European VG 95234 standard, French (NFF 61030) and British (BS 6853) electrical standards and EEC compliance directives**
- **Threaded coupling version available, contact factory for ordering information**


Dozens of contact arrangements available including hybrid Octobyte, power, and signal.


Ethernet-ready Octobyte solutions for harsh-environment applications are available as discrete contacts, packaged in rugged reverse-bayonet connectors, or as turnkey inside-the-box or environmental cable assemblies, tested and ready for immediate use.

Available flop-lid protective cover

RadGrip rubber-covered coupling nuts available in a wide range of colors including safety red

RUGGEDIZED RJ45 / USB FIELD CONNECTORS

SuperSeal®
HIGH-SPEED

SuperSeal RJ45 and USB field connectors. Now available for USB SuperSpeed 3.0

Military-grade, ruggedized field connectors that deliver improved environmental sealing, EMI/RFI grounding, and a broader range of wire termination options for RJ45 and USB—now for SuperSpeed 3.0

- **New SuperSpeed USB 3.0 protocol support**
- **Superior sealing—IP67 unmated—for complete system protection against water, sand and dust**
- **Highly durable SuperSeal™ insert design, provides enhanced operating temperature, increased life-cycle, and rugged vibration and shock performance**
- **Crimp, solder-cup, PC tail and cable assemblies**

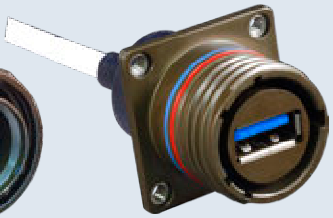
Available ruggedized memory stick
32GB, 64GB, and 128GB versions

SuperSeal High-Speed Ruggedized RJ45/USB connectors and cables

SuperSpeed USB 3.0

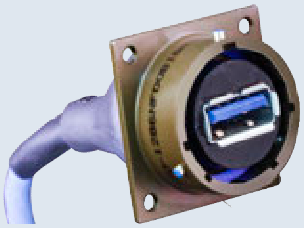
NEW SUPERSPEED USB 3.0 RUGGEDIZED FIELD CONNECTORS

Cable plug



Wall mount receptacle with metric clinch nuts

Wall mount receptacle with slotted holes



Wall mount receptacle with round holes

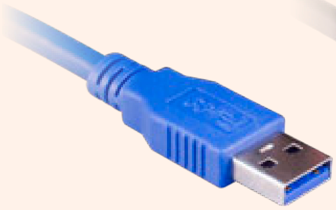
Jam nut mount Receptacle

TURNKEY SUPERSPEED USB 3.0 CABLE ASSEMBLIES AND JUMPERS

Glenair SuperNine USB 3.0 cable jumpers, SuperSeal to standard USB Type A and Micro-B connectors

SuperSeal USB 3.0 connectors are available as turnkey cable jumpers. Rugged field connector styles—including plug, wall mount and jam-nut receptacles—may be cabled with commercial 3.0 connector types including male Type A, female Type A, and male Micro B. Assemblies may be ordered with straight or right angle cable exit. In addition, the USB 3.0 insert may be ordered in horizontal or vertical orientation to provide protection against mis-mating. Maximum overall length is 15 feet.

SUPPORTED USB 3.0 CONNECTOR TYPES



USB 3.0 male Type A

USB 3.0 female Type A

USB 3.0 male Micro B

REPEATERS AND RE-DRIVERS FOR USB 3.0, DVI, HDMI

- **Extended distance signal enhancement**
- **Active cable component available now in D38999 packaging**
- **USB 5V power reduction / converter ports**

Outlook

Come As You Are

The fatal flaw in many organization "positioning plans" is that they assume accurate predictions can be made in complex human systems. In reality, they can't. In the run-up to the 1991 Persian Gulf War, the consensus opinion of highly-paid "experts" was that if hostilities broke out, oil prices would jump from the $20.00 per-barrel range to the $40.00 – $60.00 range. Well, hostilities did break out, and instead of rising, the price of oil dropped to $18.00 per barrel. This disparity between expert opinion and subsequent reality is not an unusual event. "Expert" predictions, in my life experience, have been no more accurate than the random flip of a coin.

Accepting that we can never really know what's going to happen in a complex system is in fact the best basis for dealing with the future. This is because it forces us to position ourselves to prosper under future conditions —whatever they may be.

A good illustration of this wisdom (which I am happy to admit I cribbed from one of Pete Kaufman's essays) is the concept used in urban planning called the "100-Year Flood Plain". The 100-Year Flood Plain refers to well-defined historical patterns in rain-water runoff and flooding. Basically it's the most severe cycle of flooding expected in a 100-year period of time. Urban planners use the 100-Year Flood Plain to determine the size of flood-control channels, permissible locations for dwellings, business districts, roads, and so on.

Planners relying on The 100-Year Flood Plain model realize that while the precise timing of major storms cannot be predicted, it is a virtual certainty that within a given time frame such cycles will undoubtedly occur. Accordingly, by planning for a 100 year "high-water mark", they position the community to prosper and survive, even during the worst storms reasonably expected to occur.

Most disasters—emotional, physical, or financial—come with no advance warning. We don't get to "go home and get changed" before we deal with them. But cyclically repeating factors—war/peace, boom/bust, tight money/loose money, inflation/deflation, are known "high-water marks", that we can in fact anticipate and prepare for.

Like all of you, Glenair came "dressed as we are" to COVID-19. But we are happy to report that thanks to our organizational positioning (low levels of debt, a trusting, loyal workforce, solid customer relationships, and ample factory and human resources) we have been able to weather this storm and come back stronger than ever before. For those of you who depend on us as a mission-critical interconnect supplier, you are without a doubt already experiencing our return to full-capacity manufacturing and much improved on-time delivery. My sincere thanks to everyone who worked so hard to make it all happen, and to our many loyal customers who stood by us during "the flood."

Chris Toomey

QwikConnect
GLENAIR • Volume 24 • Number 3

Publisher
Christopher J. Toomey

Managing Editor
Marcus Kaufman

Editor/Art Director
Mike Borgsdorf

Graphic Designer
George Ramirez

Technical Consultant
Jim Donaldson

Issue Contributors
Deniz Armani
Josh Castrey
Guido Hunziker
Sam Peeling
Bryan Samowitz

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

Glenair®