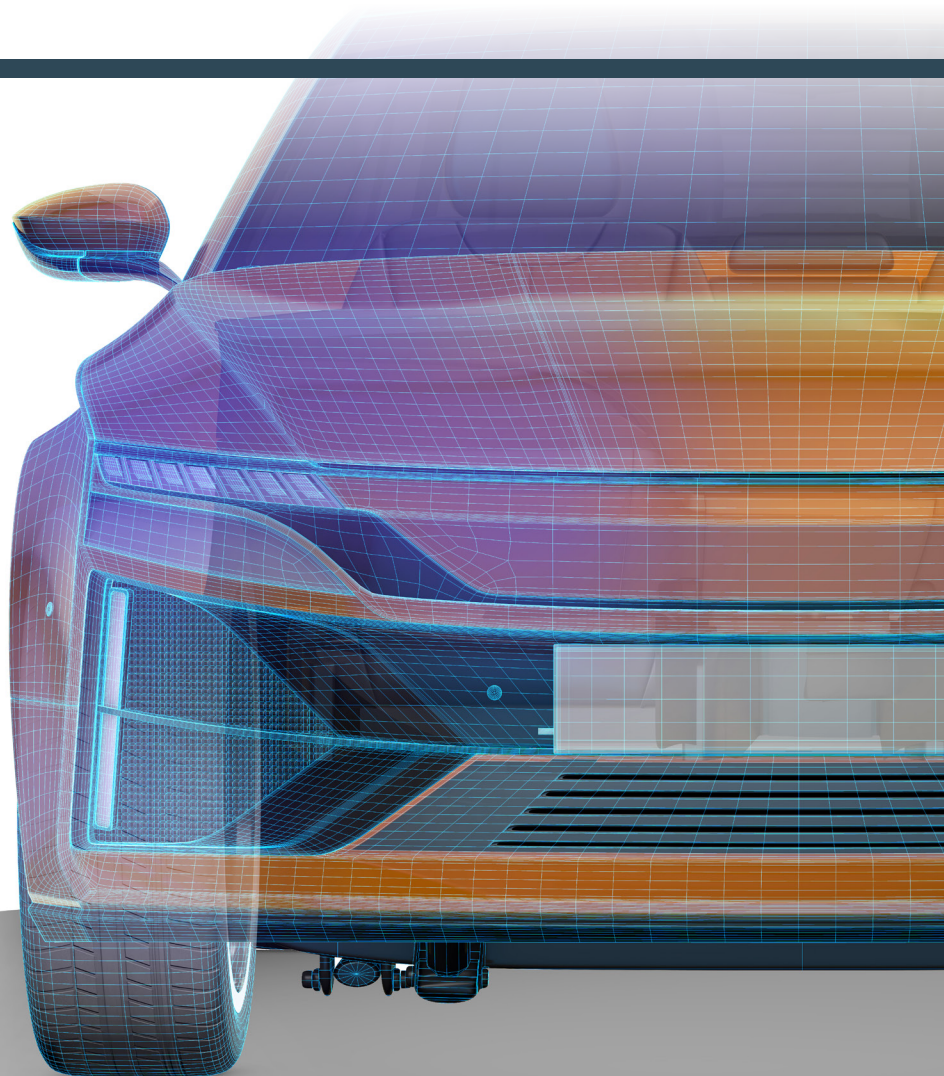
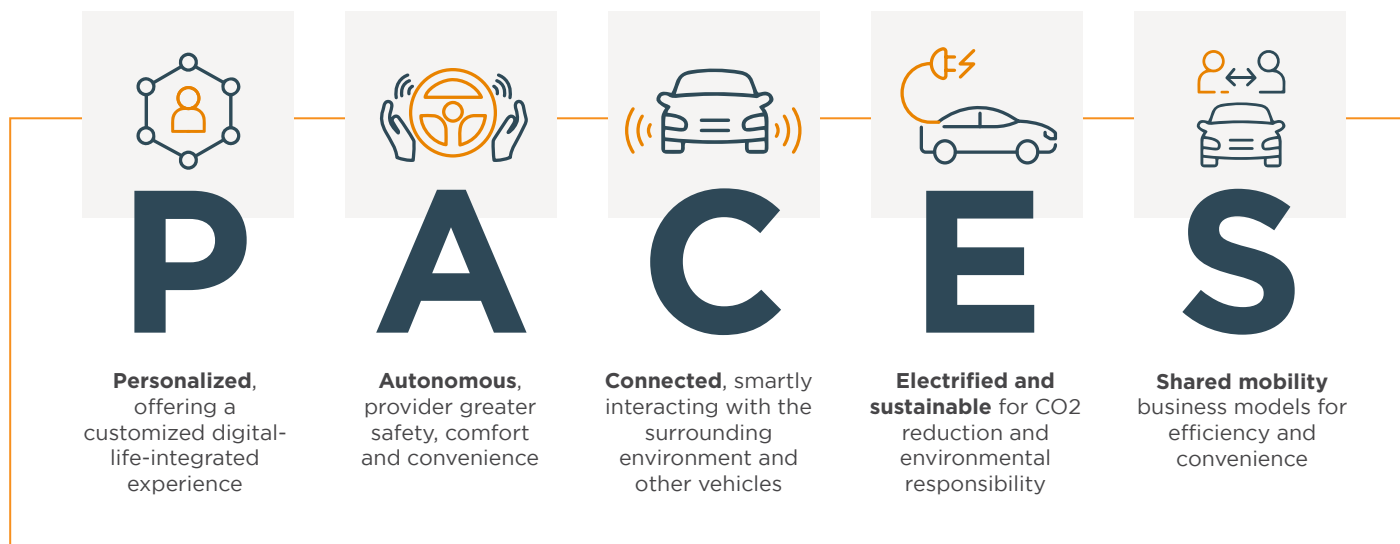

ENABLING SUPERIOR MOBILITY EXPERIENCES

End-to-End Data
Connectivity Solutions for
the Automotive Industry



Enabling Superior Mobility Experiences

The next generation of mobility can be characterized by the acronym, PACES.



These trends are driving a transformation in vehicle architectures with new functionality enabled by shared environmental data and continuous over-the-air updates that can improve performance and functionality. This software defined vehicles (SDV) enable features-on-demand and customized to driver's personal needs/preferences as well as increased safety and comfort.

SDVs are also characterized by their hardware specifications – with the requirement to be fully-equipped; with high performance computing, high speed communication, actuators, sensors and antennas with the complete range of functionality enabled through software.

Connectivity will be a key enabler of these hardwares. In addition to robust, high-speed data transmission (56Gbps+), TE's portfolio of connectors offer smart, integrated and multi-hybrid solutions as well as the ability to meet increasing FIT (Failure In Time) rates and the ability to support efficient automated assembly.

TE's extensive data connectivity portfolio offers best-in-class robust automotive-grade market compatible products as well as new innovative end-to-end solutions to support the next generation of vehicle software-enable applications.

End-to-End Data Connectivity Expertise

In addition to a comprehensive portfolio of terminals, connectors and headers for all connection types, TE provides end-to-end support for application links. This includes helping engineers to find the right solution for an application by understanding the complete link

performance, component limits, radio frequency (RF) simulation and optimal integration with the physical layer, via our header portfolio with PCB layout simulation.

<p>PHY-to-PHY Channel Analysis</p> <ul style="list-style-type: none"> • Component Limit Specification • Complete Link Performance • TEapp 	<p>Advanced Simulation Capabilities</p> <ul style="list-style-type: none"> • RF Simulation • PCB Layout 	<p>One-stop-Shop for Connectors</p> <ul style="list-style-type: none"> • Complete portfolio of terminals, connectors and headers for all connection types
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Performance

Supporting data rates up to 56 Gbps.



Robustness and Reliability

Automotive-grade interfaces with shielding (EMI), waterproofing and vibration resistance.



Smart Design

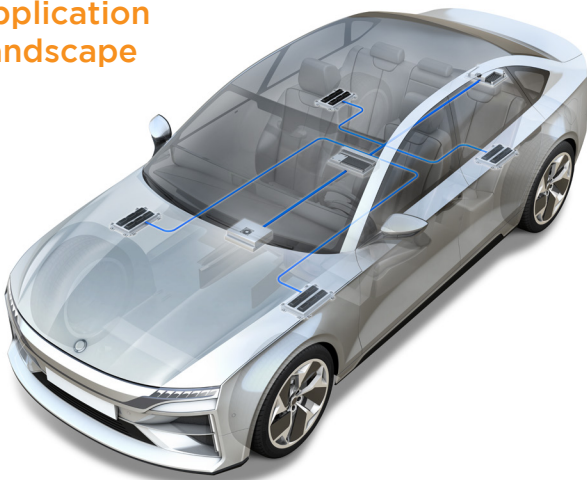
Miniaturized and modular design for optimum architecture integration.



Chip Protocol Optimized

High channel performance according to multiple chip manufacturer physical layer specifications.

Data Connectivity Application Landscape



ADAS
Connected
User Experience

Coaxial preferred

- | | |
|----------------------|-----------------|
| Mirror replacement | Surrounding cam |
| Interior Cameras | Rear view cam |
| Front View Cameras | Gesture control |
| Blind Spot Detection | |

Differential preferred

- LIDAR
- Radar
- ECU-ECU (Ethernet)



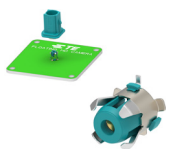
- Wi-Fi
- GPS/GNSS
- 3G/4G/5G
- V2X (DSRC, C-V2X)

- OTA
- Diagnosis
- Gateway
- High performance computer
- ECU-ECU (Ethernet)





- Rear seat entertainment
- FM, Digital audio broadcasting

- USB
- Head up Display
- ECU-ECU (Ethernet)


Coaxial Connector System

Products	Picture	Media	Bandwidth	Protocols	Speed	Example Applications	
FAKRA		Coaxial	6 GHz	SerDes: GMSL2/3, APIX3, MIPI Analog (Antennas)	Up to 6 Gbps	<ul style="list-style-type: none"> Broadcast Antennas GPS Cellular (GSM) 	<ul style="list-style-type: none"> Cameras Bluetooth Keyless Entry
MATE-AX		Coaxial	Up to 9 GHz	SerDes: GMSL2/3, FPD-Link IV, APIX3, MIPI Analog (Antennas)	12 Gbps (NRZ) 24 Gbps (PAM4)	<ul style="list-style-type: none"> 4K Cameras Sensors Hi Res. Displays 	<ul style="list-style-type: none"> WLAN Antennas Mobile Internet (3G/LTE)
CAMERA CONNECTION		Coaxial	6 GHz	FPD-Link III/IV, GMSL 2/3, MIPI, ASA, GVIF	12 Gbps	<ul style="list-style-type: none"> Rear view cameras, Surround view cameras, Night vision cameras 	<ul style="list-style-type: none"> Lane departure warning, Park assist, Driver monitoring

Differential Connector System

Products	Picture	Media	Bandwidth	Protocols	Speed	Example Applications	
HSD		Star Quad Wire	2 GHz	SerDes: GMSL1, FPDIII, APIX2, USB 2.0	Up to 6 Gbps (dual channel)	<ul style="list-style-type: none"> Legacy Infotainment Dashboard / Touch Screens 	<ul style="list-style-type: none"> HD Screens USB Connections
MATEnet		Twisted Pair	1 GHz	1000BASE-T1 100BASE-T1 HDBASET, PCIe A2B/C2B	Up to 1 Gbps	<ul style="list-style-type: none"> In vehicle network: Ethernet/ PCIe Radar/ LiDAR 	<ul style="list-style-type: none"> Rear View Cameras Multimedia (HDBASET)
GEMnet		Twisted Pair	15 GHz	100/1000BASE-T1 2.5/5/10/25GBASE-T1	Up to 25 Gbps (NRZ)	<ul style="list-style-type: none"> High performance computers, control units Radar/LiDAR 	<ul style="list-style-type: none"> High-Res. (4K) Displays In vehicle network: Ethernet/ PCIe
BEAMnet		Twisted Pair Parallel Pair		GMSL3, APIX3, GVIF3, FPD-Link IV, ASA Motion Link, MIPI A-PHY and HDBaseT / USB and PCIe (BEAMnet only)	56 Gbps (PAM-4)		

Multi-Hybrid Connector System

Products	Picture	Media	Bandwidth	Protocols	Speed	Example Applications	
NET-AX+		Differential / Coaxial + Signal/ Power	15 GHz	Automotive Ethernet 100BASE-T1, 1000BASE-T1, 2.5/5/10/25GBASE-T1 SerDes: GMSL3, APIX3, GVIF3, FPD-Link IV, ASA Motion Link, MIPI A-PHY, HDBase-T Others: USB, PCIe	Up to 25 Gbps (NRZ) 56 Gbps (PAM-4)	Multi-port Electronic Control Units (Space & Weight savings + Modularity)	Next generation ADAS & Infotainment modules for new architectures

FAKRA Coaxial System for Radio Frequency

Automotive manufacturers are increasingly designing safety and vehicle connectivity applications based on high frequency data connections. These include cameras, sensors and antennas that require real-time data transmission where safety is the number one priority. Enabling RF performance up to 6 GHz, TE Connectivity's FAKRA coaxial connectors offer high performance as well as increased levels of robustness for harsh automotive environments.

In addition, the portfolio includes simplified stamped and formed terminals that offer lower mating forces and increased automotive robustness as well as readiness for fully automated cable assembly that can significantly increase efficiency of cable processing and reduce production costs.

KEY FEATURES AND BENEFITS

Automotive-grade robustness

- Tulip contact/anti-stubbing
- Housing inner-ring/anti-scooping
- Closed cage outer contact/beam protection
- 10 mating cycles
- Reduced mating forces with increased levels of robustness

Manufacturing Efficiency

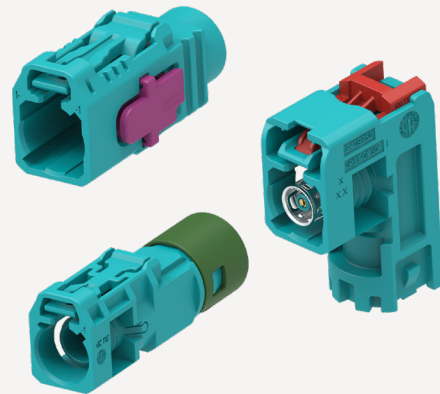
- Sub-assembly, center contact, and ferrule on strip
- Designed for fully and semi-automated cable assembly

Extensive Portfolio

- CPA capable
- Full product portfolio: sealed unsealed, 180° and 90°
- Available for RG-174, RTK-031 - unsealed and sealed

LEARN MORE

- [FAKRA Automotive Connector System Landing Page](#)
- [FAKRA Automotive Connector System Catalog](#)
- [FAKRA Stamped and Formed Terminal and Connector System](#)
- [FAKRA Automated Terminal and Connector System](#)



APPLICATIONS

- Autonomous driving: 4KADCAM, Night Vision, e-Mirror, Lane Assist, front view cameras, interior cameras, surrounding cameras, rear-view cameras
- Connected vehicle: TCU, 4G/5G, V2X, Bluetooth Low Energy, Wi-Fi, Bluetooth, GPS/GNSS, SDARS (Satellite Digital Audio Radio Service)
- User experience: FM, DAB, Gesture

SUPPORTED PROTOCOLS

- Serializer/Deserializer (SerDes)
- GMSL 2/3
- APIX3

MATE-AX Miniaturized Coaxial Connectors

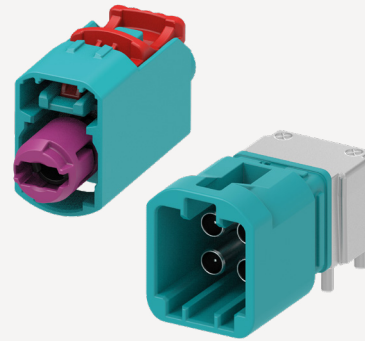
TE Connectivity's MATE-AX miniaturized coaxial connector system provides advanced automotive data transmission performance supporting up to 9 GHz bandwidth, while supporting up to 75% PCB footprint reduction. The extensive portfolio, offering a wide range of connector types and sizes, can support all types of RF-based applications. By supporting existing wire types, MATE-AX miniaturized coaxial connector system enables flexible integration into existing coaxial architectures.

KEY FEATURES AND BENEFITS

- **Automotive Grade Robustness**
 - Fully compliant with LV214 & USCAR49 requirements
 - Anti-stubbing features prevent improper connections and pin damage
 - Fully protected terminals with inward-facing contact points
- **Space Reduction**
 - One of the shortest terminal on the market provides additional space in the installation area
 - Up to 75% PCB footprint reduction compared to standard FAKRA solutions
- **Manufacturing Efficiency**
 - Terminal design optimized for automated manufacturing
 - Support of existing wire types ensures integration into existing architectures
 - Global manufacturing footprint

LEARN MORE

- [MATE-AX Connector System Landing Page](#)
- [MATE-AX Connector System Video](#)
- [MATE-AX Connector System Brochure](#)
- [MATE-AX Connector System Whitepaper](#)



APPLICATIONS

- **Cameras**
 - Surround View, Lane Assist, High Beam Assist, Blind Spot Detection, Traffic Sign Recognition, Rear View, Driver Monitoring, Gesture Control, Night Vision, Mirror Replacement
- **Antennas**
 - 4G, LTE, Smart 5G, Keyless Entry, Remote Parking, Bluetooth, WLAN, V2X, DSRC, C-V2X

SUPPORTED PROTOCOLS

- GMSL2/3
- FPD-Link III/IV
- APIX3
- MIPI
- ASA (Automotive SerDes Alliance)

Automotive Coaxial Camera Connectors

A growth in the deployment of ADAS and automated driving technologies is leading to an increase in the number of cameras applications, which include surround view, lane departure warning, adaptive cruise control, blind spot recognition and smart cameras that recognize the environment. TE's innovative broadband coaxial connector portfolio that is precisely tailored to the requirements of next-generation automotive camera systems.

Based on TE's MATE-AX and FAKRA interfaces, the fixed and floating camera connection solutions offer a misalignment compensation of +/- 0.5 mm in all dimensions and a sealing rating of IP6K9K. In addition, with up to 6GHz bandwidth, TE's camera connector solutions can support the most advanced cameras with 12 megapixels / 60 fps and beyond.

KEY FEATURES AND BENEFITS

Automotive-grade robustness

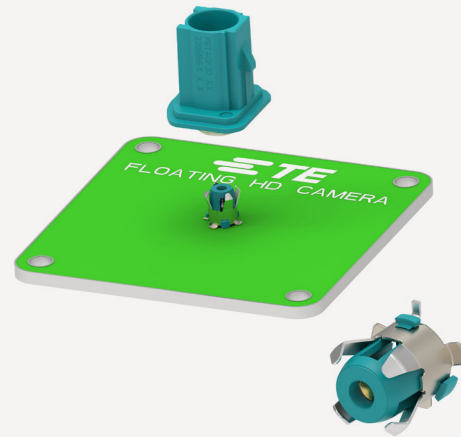
- Portfolio of floating and fixed header solutions
- Single and multi-PCB support
- High-level of misalignment compensation: 3 0.5 mm in all directions for floating solutions
- Highly compact design
- IP69K Waterproof

High Performance

- 6 GHz performance, supporting all current and next-generation automotive coaxial SerDes protocols
- Broadband connectivity capable of 12 MP @ 60 fps and beyond

LEARN MORE

- [Automotive Coaxial Camera Connectors Landing Page](#)
- [Automotive Coaxial Camera Connectors Brochure](#)



APPLICATIONS

- Rear view cameras
- Lane departure warning
- Park assist
- Surround view cameras
- Adaptive cruise control
- Driver monitoring
- Night vision cameras

SUPPORTED PROTOCOLS

- FPD-Link III/IV
- GMSL 2/3
- MIPI
- ASA
- GVIF

HSD/HSL

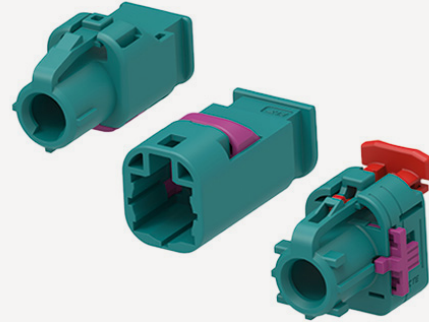
TE Connectivity (TE) manufactures fully shielded HSD and HSL connector systems supports up to 6 Gbps and 1Gbps respectively, accommodating different wire types and sizes. Compatible with LVDS, Ethernet and USB protocols, it features a full range of headers and connectors for unsealed and sealed applications. Both HSD and HSL products have been designed specifically for automated manufacturing and benefit from TE's truly global manufacturing footprint.

KEY FEATURES AND BENEFITS

- Full range of connectors for unsealed and sealed applications
- High level of process automation and global manufacturing footprint
- Compatible with the German AK HSD interface
- Validated with various types of shielded star-quad cables 4x0.14 mm², 4x0.22 mm², 4x0.5 mm² • 0.8 μm Au surface in terminal mating area to meet automotive requirements
- Impedance optimized HF Design supported by stamped signal pin profiles

LEARN MORE

- [HSD Connector System Landing Page](#)
- [HSD Connector System Brochure](#)
- [HSL Connector System Landing Page](#)



APPLICATIONS

- Legacy infotainment
- Dashboard/Touch Screens
- HD Screens
- Bluetooth
- USB connections
- Dual band Wi-Fi
- Surround Cameras

SUPPORTED PROTOCOLS

- LV214, USCAR 2, REV 5, LVDS, Ethernet and USB protocols, IEEE 1394 (Firewire), GVIF, MOST

MATenet Modular and Scalable Miniaturized Data Connector System

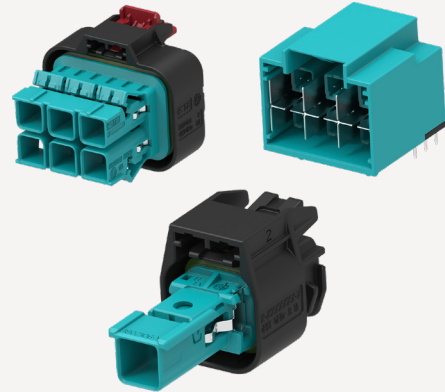
TE Connectivity's MATenet family is modular and scalable connector system, developed for the latest generation of vehicle architectures. Based on proven standard miniaturized terminals and available in shielded (STP) and unshielded (UTP) versions, MATenet meets data transmission requirements according to 100BASE-T1 and 1000BASE-T1. In addition, MATenet uses higher modulation data transmission technologies, enabling it to support data rates up to 4 Gbps.

KEY FEATURES AND BENEFITS

- **Automotive grade robustness**
 - Based on proven NanoMQS terminals system
- **Higher data-rate**
 - Supports up to 1 Gbps (potential for 4 Gbps with alternative technologies)
- **More flexibility**
 - Compatible with Unshielded Twisted Pair (UTP) and Shielded Twisted Pair (STP)
- **Modular and scalable solution**
 - Integrates into existing automotive connectivity interfaces
- **Cost efficient**
 - Design and process aligned for Automotive Ethernet
 - Extensive advanced application supported

LEARN MORE

- [MATenet Connector System Landing Page](#)
- [MATenet Connector System Brochure](#)
- [MATenet Connector System Whitepaper](#)



APPLICATIONS

- In vehicle networking: Ethernet/PCIe
- Rear view camera
- Multimedia (HDBASET)
- LiDAR/Radar applications
- Onboard diagnostics
- Surround camera

SUPPORTED PROTOCOLS

- IEEE conformance: 100BASE-T1 (100Mbps - IEEE802.3bw) and 1000BASE-T1 (1 Gbps - IEEE802.3bp PoDL / Class 3-48 Volt)
- A2B
- HDBaseT

GEMnet Multi-Gigabit Differential Connector System

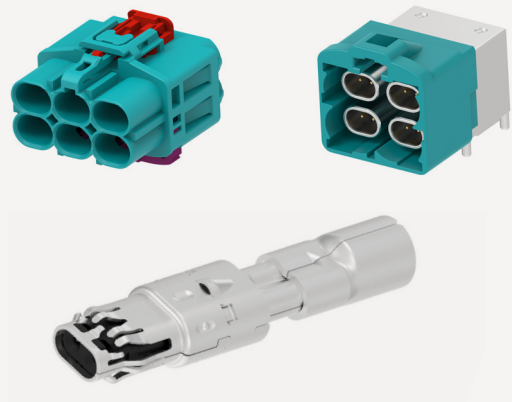
TE Connectivity's GEMnet differential terminals and connectors is designed for the next-generation of automotive data connectivity applications. The automotive grade connector system offers up to 15 GHz bandwidth / 56 Gbps data transmission, by supporting multi-gigabit ethernet , SerDes and other application protocols.

KEY FEATURES AND BENEFITS

- **High performance**
 - Up to 15 GHz, capable of supporting 56 Gbps
 - Simplified cable termination process provides reliable RF performance
- **Automotive Robustness (LV214 and USCAR qualified)**
 - Class 1 vibration stability, primary and secondary locking, anti-stubbing, scoop proof and optional connector position assurance (CPA), and high cable retention force
 - High EMI performance from multiple contact points
- **Extensive portfolio**
 - Based on 90° and 180° terminals, TE offers sealed/unsealed 1,2,4,6 port connectors and headers

LEARN MORE

- [GEMnet Connector System Brochure](#)
- [GEMnet Connector System Video](#)
- [GEMnet Connector System Landing Page](#)



APPLICATIONS

- Automotive Ethernet: 100BASE-T1, 1000BASE-T1, 2.5/5/10GBASE-T1
- 4K Camera systems
- 8K/High-resolution displays
- LiDAR/Radar applications
- High performance Computers (HPCs) /Control units (e.g., Autonomous driving, connected vehicle and infotainment)
- Rear seat entertainment

SUPPORTED PROTOCOLS

- Automotive Ethernet: 100BASE-T1, 1000BASE-T1, 2.5/5/10GBASE-T1
- SerDes: GMSL, APIX, GVIF, FPD-Link, ASA Motion Link, MiPi, HDBase-T
- Others: USB, PCIe

BEAMnet Differential Connector System

TE Connectivity's BEAMnet differential terminals and connectors is designed for the next-generation of automotive data connectivity applications. While the miniaturized interface enables space savings up to 50%, it still supports the bandwidth demands of all upcoming automotive high-speed protocols like 25 Gbps Ethernet.

KEY FEATURES AND BENEFITS

- Miniaturization: 50% smaller interface section than H-MTD
- High-speed data transmission: supports all present and next gen protocols like 25 Gbps automotive Ethernet
- Shielding: fully-shielded design guarantees excellent EMC properties
- Scalability: beam contact design enables interface extension for multilane applications like PCIe



SUPPORTED PROTOCOLS

- Automotive Ethernet: 100/1000BASE-T1 and 2.5/5/10/25GBASE-T1
- SerDes: GMSL3, APIX3, GVIF3, FPD-Link IV, ASA Motion Link, MIPI A-PHY and HDBaseT
- Others: USB and PCIe (multi-lane)

NET-AX+ Modular Hybrid Data Connector System

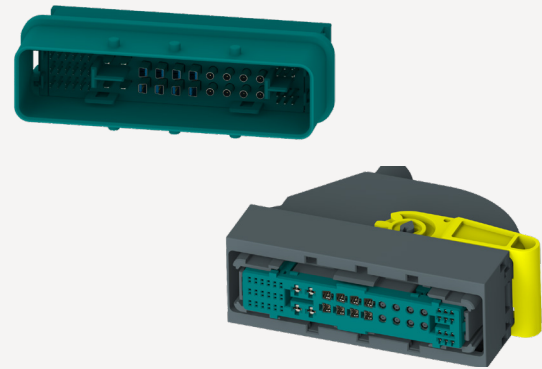
TE Connectivity's NET-AX+ connector system is designed to support the next-generation of centralized and zonal architectures (particularly Autonomous driving & advanced driver assistance and Infotainment ECUs, and HPCs). Its flexible, modular design supports coaxial and differential data connectivity for multi-gigabit Ethernet, SerDes and other application protocols as well as signal and power connections - all in one integrated connector assembly.

KEY FEATURES AND BENEFITS

- High Performance
- Miniaturized STP channel fulfilling the most demanding bandwidth requirements for upcoming
- Ethernet speeds (e.g. 25GBASE-T1: 25 Gbps / 9 GHz)
- Modular and space saving design
- Coaxial and differential support as well as signal and power connectivity in a single connector
 - Up to 40% PCB space reduction
 - Up to 80% fewer mating assemblies
 - Highly customizable solution
 - Modular design supports multiple hybrid configurations
- Extensible Configuration
 - Supports customer-specific hybrid configurations
- Customizable and modular connector design

LEARN MORE

- [NET-AX+Modular Hybrid Data Connector System Landing Page](#)



SUPPORTED PROTOCOLS

- Automotive Ethernet: 100/1000BASE-T1 and 2.5/5/10/25GBASE-T1
- SerDes: GMSL3, APIX3, GVIF3, FPD-Link IV, ASA Motion Link, MIPI A-PHY and HDBaseT
- Others: USB and PCIe (multi-lane)

Fiber Optic Connections

TE connectivity's Fiber optic connector system offers a broad product range of physical layer components for devices communicating on Media Oriented System Transport (MOST) network. TE's fiber optics provide a complete range of components for MOST 25 and MOST 150 connectors including PCB and harness connectors, cable assemblies and processing equipment. The development of these components is backed by TE's knowledge of optics and collaboration with Tier 1 and Tier 2 customers. TE developed an optical high speed multimedia network based on 1000 μm polymere optical fiber (POF) supporting data-speed of 25 Mbps and 150 Mbps.

KEY FEATURES AND BENEFITS:

- Supports data-speed of 25 Mbps and 150 Mbps
- No electromagnetic interference (EMI)/electromagnetic compatibility (EMC) interferences at the cable
- Reflow and wave soldering versions available for headers
- Pigtail versions have the flexibility to be soldered at the header and at the connector independently. This flexibility ensures that the plastic of fiber is not damaged by solder heat
- Wide range of connectors and headers available
- Light weight of polymer optical fiber (POF)
- Application is based on optical ring structure with various nodes and less cabling is required
- Cost efficient-design and process aligned for automotive market needs
- Modular and scalable solution that fits automotive connectivity building blocks and OEMs
- Cable harness product range along with repair tool set available



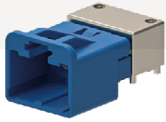
SUPPORTED PROTOCOLS

- Media Oriented System Transport (MOST) cooperation compliant
 - 1000 μm Polymer Optical Fiber (POF)
 - Available for Media Oriented System Transport (MOST) MOST 25 and MOST 150 protocol
 - ISO standard (preliminary)

USB TYPE-C

As next-generation solution for current and future USB applications, our USB Type-C connectors are designed to an industry standard that provides a sleek, slim design small enough for handheld devices and robust enough for industrial applications. This connector supports a variety of different protocols, and with the use of adapters, it is backward compatible to HDMI, VGA, DisplayPort, and other types of connections from the single USB Type-C port. We provide a distinctive electromagnetic interference (EMI) design on the back of the receptacle shell to help eliminate unwanted EMI leakage, as well as enhanced board retention features.

90 degree header



MOST 150 fully-shielded pigtail



Semi-shielded pigtail



180 degree plug

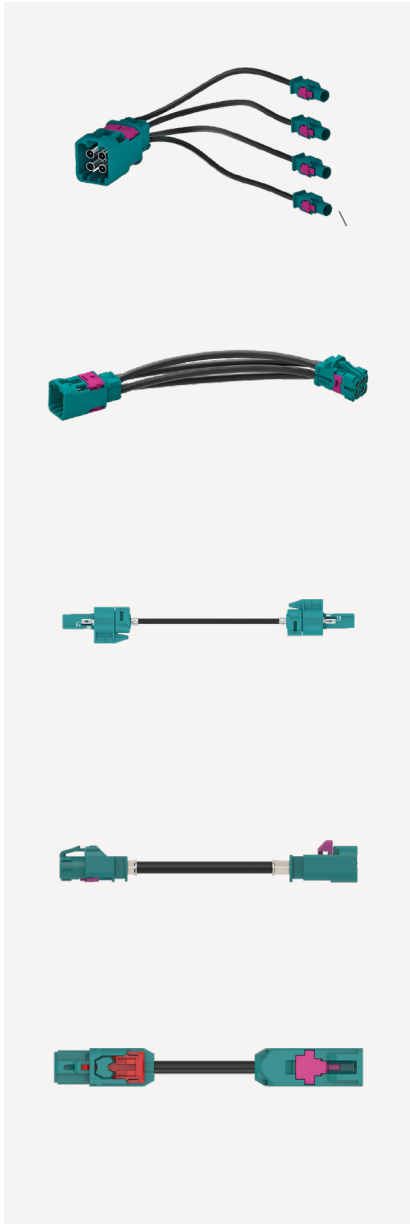


180 degree inline



TE Connectivity Cable Assemblies

TE produces highly reliable cable assemblies for coaxial, differential and optical data connectivity technologies. We offer research and development capabilities, rapid prototyping and samples, as well as manufacturing facilities. The cables include over-molding technology, semi and fully-automatic manufacturing processes testing equipment as well as handling of high and low volume production.



Coaxial Cable Assembly

4 port 180° Female MATE-AX/4x1 port 180° Female FAKRA
(Available cable types: RTK031/RG174)

MATE-AX Cable Assembly

4 port 180° Male MATE-AX/4 port 180° Female MATE-AX
(Available cable types: RTK031/RG17)

MATEnet Cable Assembly

1 port 180° Female MATEnet/1 port 180° female MATEnet
(Available cable types: UTP 100Mbps/STP 1Gbps)

HSD Cable Assembly

1 port 180° Female HSD/1 port 180° Male HSD
(Available cable types: Inliner, Dual & sealed versions,
with cross sections 0.14, 0.22 and 0.5 Sq mm STQ cables)

GEMnet Cable Assembly

1 port 180° Male GEMnet/1 port 180° Female GEMnet
(Available cable types: UTP 100Mbps /STP 25Gbps)

TE Connectivity Application Tooling

Data connectivity applications based on TE's MATE-AX connector systems require proper wire termination to deliver optimum performance. TE's AMP-O-LECTRIC GII Terminator is therefore engineered with precision crimp height adjustment; variable speed, split-cycle operation; and quality monitoring features.

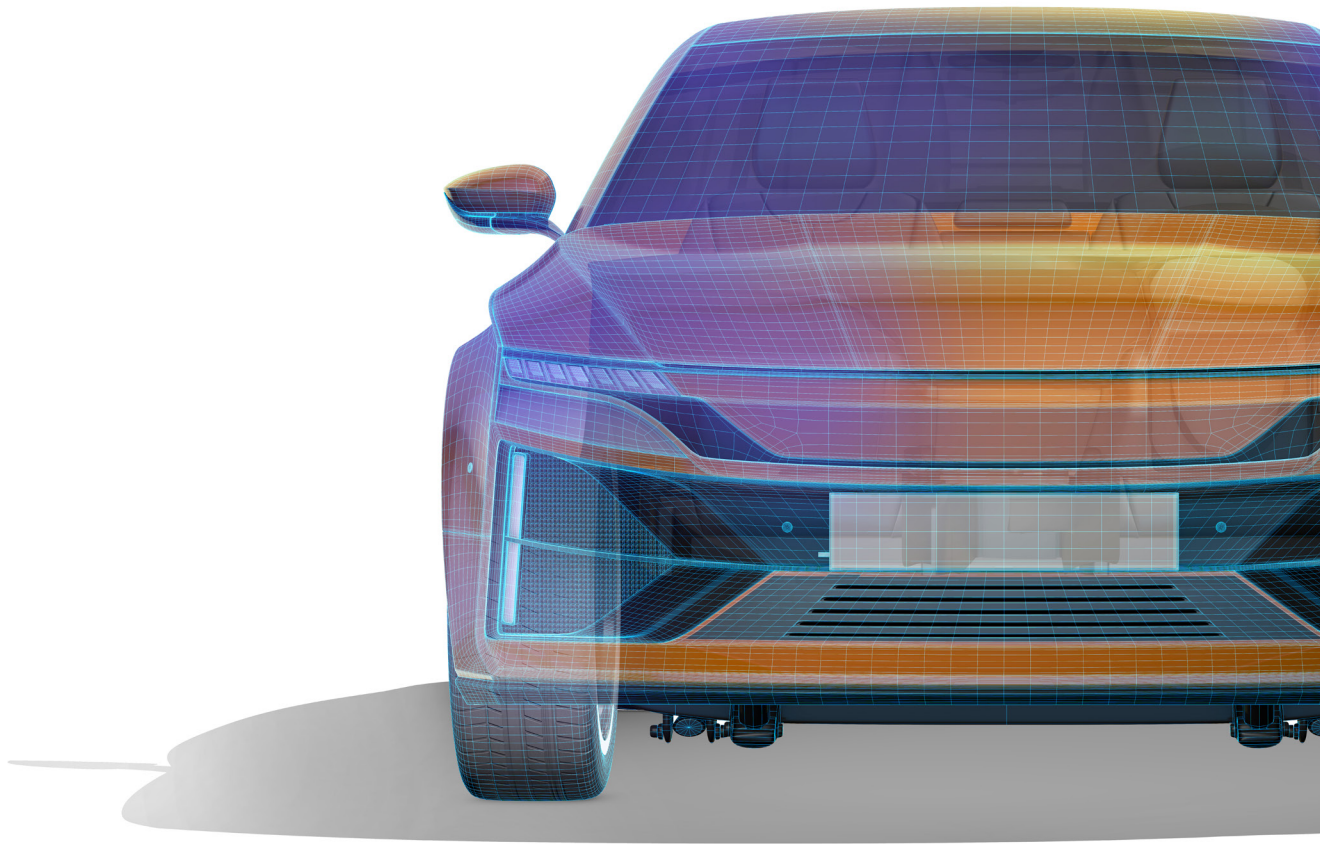
Visit TE.com to learn more about how TE's GII Terminator is engineered with advanced features to meet the needs of data connectivity applications and to enhance your productivity.



AMP-O-LECTRIC GII TERMINATOR



OCEAN APPLICATOR 2.0



FOR FURTHER INFORMATION PLEASE CONTACT US:

EUROPE

Germany

Product Information Center:

Phone: +800 0440-5100

Fax: +49 6251-133-1988

Email: ConnectedSales@te.com

UNITED STATES

United States - Harrisburg

Product Information Center:

Phone: +1 800 522-6752

Fax: +1 717-986-7575

Web: TE.com/customerservice

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TE Connectivity Germany GmbH

Ampèrestrasse 12-14

64625 Bensheim / Germany