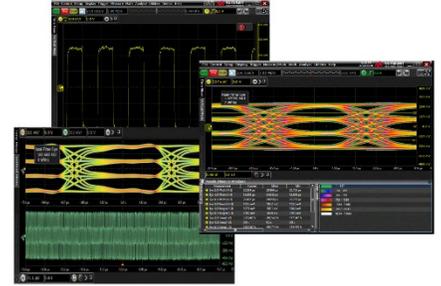# From Standard Ethernet to Automotive Ethernet

What is the difference, really?

An Automotive Ethernet Tip

Standard Ethernet

Standard Ethernet, BASE-TX has proven itself as a secure transfer medium that can handle large amounts of data in internet infrastructure companies and high-speed data centers, as well as offices, and homes. The advantages of Ethernet — multi-point connections, higher bandwidth, and low latency — are attractive to automotive manufacturers. However, traditional Ethernet did not meet the EMI/RFI requirement set by the OEMs and is interference-sensitive, making it less than ideal for use in the harsh conditions in a vehicle.

Automotive Ethernet

With more sensors, controls, and interfaces all using higher bandwidth, faster data throughput and more reliable networks are required. Automotive Ethernet is a physical layer standard designed for use in automotive connectivity applications. IEEE standardized the technology with 802.3bw (100BASE-T1) expanded to add 802.3bp (1000BASE-T1) as well as 802.3.cg (10BASE-T1S) and 802.3ch (2.5/5/10 GBASE-T1). New 802.3cy (25 Gbps), 802.3cz (optical 2.5/5/10/25/50Gbps) and 802.3dh automotive Ethernet standards are in the works to provide connectivity greater than 10 Gbit/s. The weight of the cables and harnesses in the vehicle is large concern to manufacturers. Automotive Ethernet is implemented with a single twisted cable pair, and therefore the overall weight of the cable harness can be reduced by as much as 30%.

Cables

The automotive Ethernet cable for up to 1000base-T1 is a single unshielded twisted pair (UTP) making it low-weight and low-cost to manufacture. However, for higher than 1000base-T1, a single shielded twisted pair (STP) is used for better RF/EMI protection and higher data transmission speeds. Unlike standard ethernet, with a dedicated transmit-and-receive path, automotive Ethernet, has a single twisted pair being used for both transmit and receive operations at the same time, also referred to as full duplex communication. This implies that both ends of the link employ a hybrid transceiver that's capable of distinguishing what it is sent from what's it is receiving.

KEYSIGHT

Length

Electrical automotive Ethernet was specified for a maximum of just 15m, since the automotive applications don't need a long distance to connect devices within a vehicle, and the shorter length allows for lighter cabling. Longer reach connection in the vehicle is being addressed by optical automotive ethernet (802.3cz) where the maximumcable length will be 40 m using graded index glass optical fiber.

Signal Encoding

PAM-3 is employed in the automotive standard for both the 100base-T1 and 1000base-T1 versions. For MultigigBase-T1 standards, a PAM4 modulation is used. Signal encoding refers to the different data encodings, or data modulation schemes, meaning the map of raw data bits to symbols as they're transmitted on the link. A combination of the signal encoding, and the modulation type, serve to achieve target spectral efficiencies, and that is something automotive Ethernet does well. In automotive Ethernet particularly, there is a need to transmit as many symbols for the least amount of bandwidth possible.

Connector

RJ45 is the classic, standard interface for home and office Ethernet. The connector type for automotive Ethernet is not defined. This can be an issue in form fitting standard test requirements and does require some custom cabling and fixtures.

Comparsion between standard and automotive Ethernet

	Standard Ethernet	Automotive Ethernet
Data rate	100 Mbps to 400 Gbps	10 Mbps to 10 Gbps
Length	Depends on the data rate 100 m to 2 km is not uncommon	15 m
Connector	RJ45	Not defined
Cable	Coax to fiber optic depending on the speed	Copper, a single twisted pair with bi-directional data

Summary

As the demand for bandwidth, data rate, and data security continues to go up for in-vehicle communication, automotive Ethernet overcomes the limitations of traditional automotive serial buses and offers advanced capabilities to meet the needs.

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