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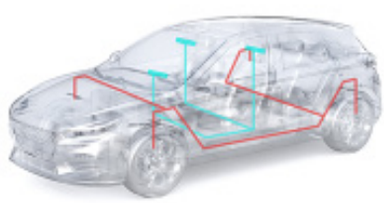
Common Mode Chokes and Chip Varistors for 10BASE-T1S

EMC Components | Voltage / Current / Temperature Protection Devices | Chip Varistors / Ceramic Transient Voltage Suppressors | Common Mode Filters / Chokes



While the development of next-generation vehicles for fully automated driving is gaining momentum, vehicle architecture is beginning to undergo major changes. Among them, the automotive network that connects ECUs responsible for advanced driver-assistance system (ADAS) is a very important element.
One particular focus is on automotive Ethernet for automotive networks, with 100BASE-T1 (100 Mbps) and 1000BASE-T1 (1 Gbps) for sensor systems in cameras, radar, and LiDARs. Furthermore, the 10BASE-T1S, a new standard for automotive Ethernet with a transmission speed of 10 Mbps, is gaining more attention.
Sample applications: Possible applications include actuator systems and sensors.

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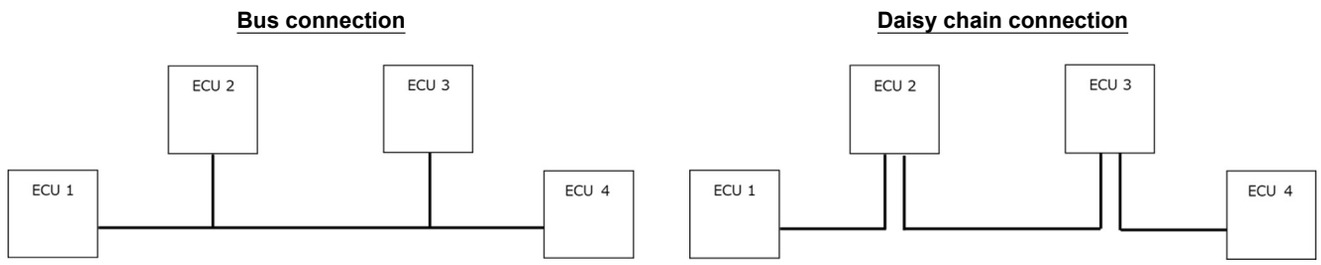
10BASE-T1S Overview

10BASE-T1S is one of the latest IEEE Automotive Ethernet standards established as part of the IEEE 802.3cg standard. It uses an unshielded twisted pair (UTP) cable with two unshielded cores for communication.
Unlike 100BASE-T1 and 1000BASE-T1, which are one-to-one peer-to-peer connections (Figure 1) that require a switch for network configuration, 10BASE-T1S can perform multi-drop connections (Figure 2) without the need for a switch, thus reducing cost. This makes it Even when the number and complexity of networks increase as electronic systems become more advanced, it is possible to build more flexible and faster architectures.

Figure 1: 100BASE-T1, 1000BASE-T1 (Peer-to-Peer Connection)

Figure 2: 10BASE-T1S (Multi-drop connection)



Recommended Products for 10BASE-T1S (Common Mode Chokes/Filters)

Since 10BASE-T1S adopts a multi-drop connection without a switch, when many ECUs are connected on one line, reflections due to the length of the wire harness and branches, and the capacitance component of the ECUs become bigger, which may then cause ringing due to the communication waveform. For this reason, common mode chokes for EMC measures must have as low interline stray capacitance as possible, and products with good mode conversion properties (Sds21, Sds12, Ssd21, Ssd12) are also required. That's why TDK's common mode choke coils are designed to have both excellent interline stray capacitance and mode conversion properties, making them the ideal product for 10BASE-T1S.

Table 1: 10BASE-T1 Recommended Common Mode Chokes/Filters

Compliant with OPEN Alliance - 10BASE-T1S EMC Test Specification

Product No.	Common Mode Inductance µH (Typ) @ 100 kHz	Parasitic Capacitance pF (Max)	DC resistance Ω (Max)	Rated Current mA (Max)
ACT1210E-241-2P-TL00	240	10	4.1	70
ACT1210E-131-***(*1)	130	7	TBD	TBD

*1:Under Development

Recommended 10BASE-T1S Products (Chip Varistors / Ceramic Transient Voltage Suppressors)

Similar to common mode choke coils, ESD countermeasure components also require stringent specifications. In particular, capacitance and capacitance tolerance require products with lower capacitance and narrower tolerance than general ESD countermeasure components. TDK's product lineup of chip varistors for ESD countermeasure components has a maximum capacitance of 1.5 pF (Typ) and a capacitance tolerance of ±0.13 pF, thereby providing low capacitance and narrow tolerance products. This enables ECU designs with high immunity by minimizing the impact on communication quality and mode conversion characteristics. Needless to say, TDK chip varistors also offer high ESD protection performance and comply with the AEC-Q200 automotive reliability standard, making them an excellent overall balance as ESD protection component for automotive Ethernet applications.

Table 2: 10BASE-T1 Recommended Chip Varistors / Ceramic Transient Voltage Suppressors

Product No.	L x W Dimensions mm	Varistor Voltage V (Nom.) @ 1 mA	Capacitance pF	ESD Resistance IEC61000-4-2
AVRH10C101KT1R2YE8	1.0×0.5 EIA0402	110(100 to 120)	1.23(1.1 to 1.36)	8kV
AVRH10C221KT1R5YA8	1.0×0.5 EIA0402	220(198 to 242)	1.5(1.37 to 1.63)	25kV

S-Parameter

In general, for automotive Ethernet, the mode conversion characteristics (Sdc11, Ssd21, Ssd12), return loss (Sdd11), and insertion loss (Sdd21) are used for component selection and ECU design.
Standard lines (Sdd11, Sdc11) have been established for these S-parameters in IEEE802.3cg, while the OPEN Alliance is currently formulating them.
Therefore, the S-parameters of individual components and the S-parameters of combined components are important indicators in designing an ECU.
Below are the S-parameters for typical common mode chokes and varistors (Typ value).

Figure 3: Sdd11

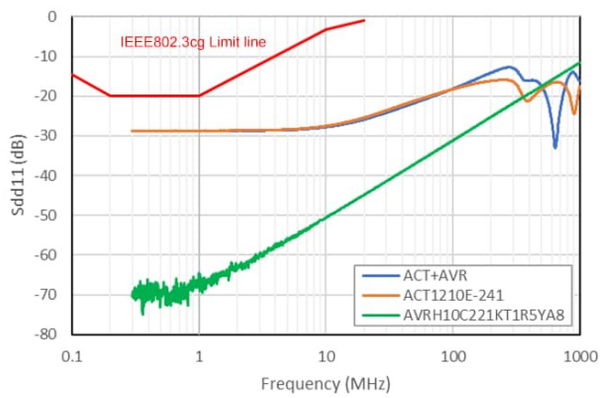


Figure 4: Sdc11

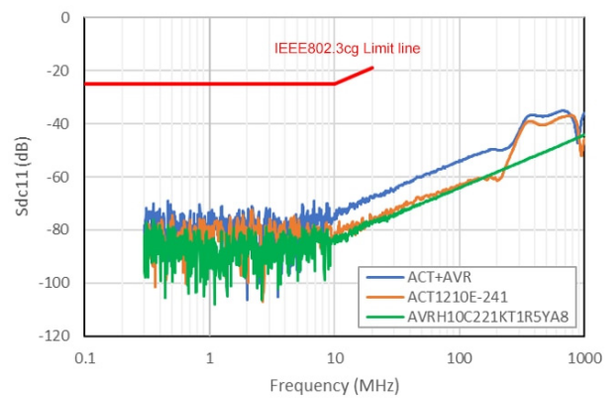


Figure 5: Sdd21

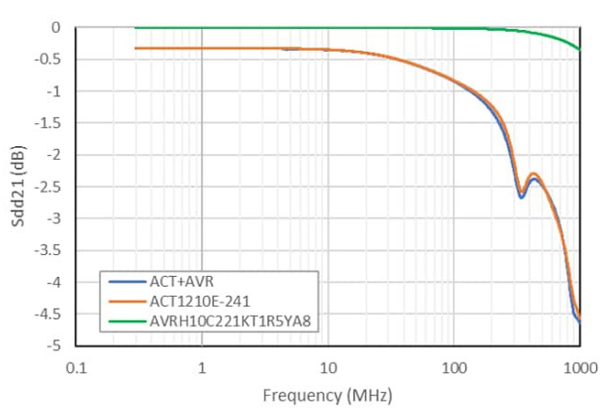


Figure 6: Scc21

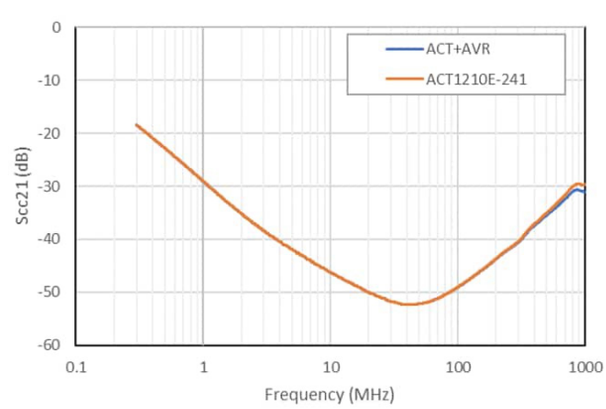


Figure 7: Ssd21

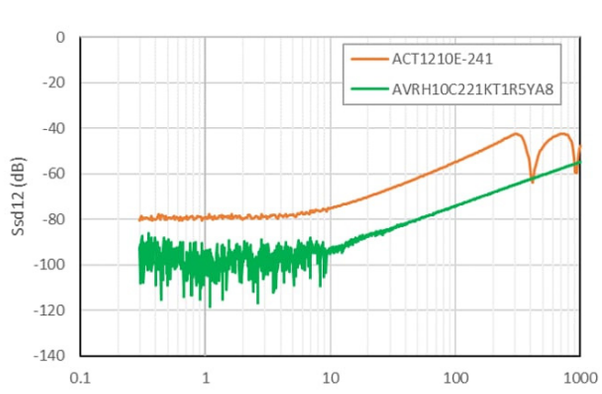
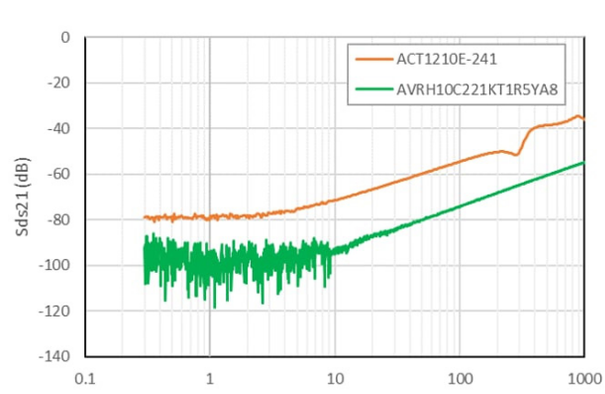


Figure 8: Ssd12

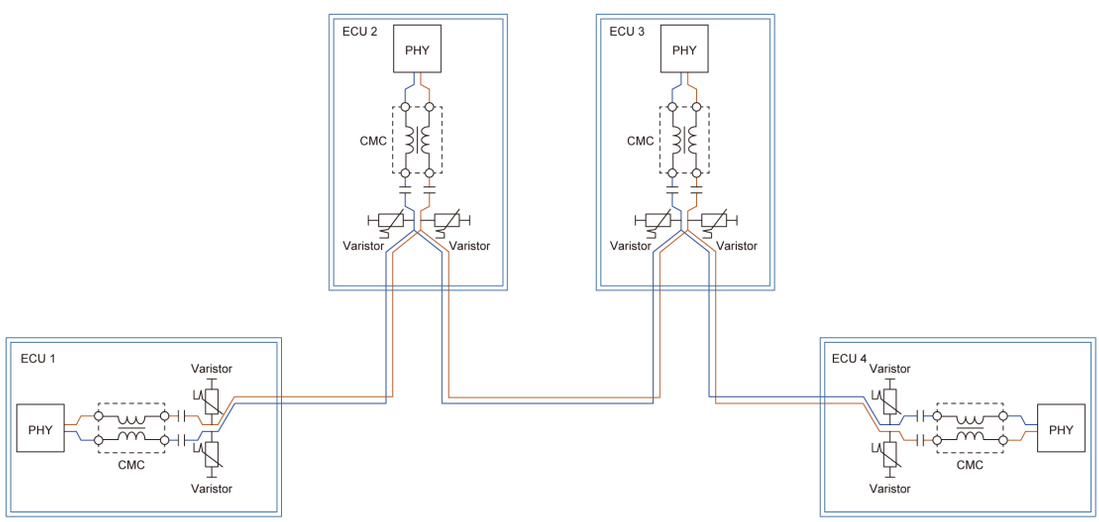


About Mode Conversion

Differential communication signals flow in a conducted mode called differential mode. The noise that flows in a conducted mode is called the common mode. From time to time, due to the influence of electronic components used in differential communication lines, this conduction mode can be converted from differential mode to common mode, or from common mode to differential mode. This conversion of the conduction mode is called mode conversion. Due to this conduction mode conversion (mode conversion), differential signals are converted to noise, or noise is converted to differential signals, resulting in poor noise immunity of the ECU itself. This may lead to ECU malfunction, or the ECU itself may emit noise. The electronic components' effects that cause these issues are generally due to asymmetries in differential communication lines. Asymmetry refers to characteristics such as the difference in inductance and capacitance. As shown in Figures 4, 7, and 8, the products introduced in this article have excellent mode conversion characteristics.

Common Mode Chokes and Chip Varistors in a Daisy Chain Connection

Figure 7: 10BASE-T1S (Multi-drop connection)



IEEE802.3 Physical Layer Standard

For 10BASE-T1S, the physical layer specifications and management parameters for 10 Mbps operation and power supply have already been established as part of IEEE802.3cg 10 Mbps Single Pair Ethernet.
Discussions are currently underway to develop the physical layer specification for enhancing cable length and number of nodes of the IEEE802.3da's 10 Mbps single pair multi-drop segments, as well as the development of enhanced control parameters.

	10BASE-T1	100BASE-T1	1000BASE-T1	Multi-Gig BASE-T1
IEEE	IEEE802.3cg	IEEE802.3bw	IEEE802.3bp	IEEE802.3ch
Transmission Speed	10Mbps	100Mbps	1Gbps	2.5/5/10Gbps
Coding	4B/5B (DME)*2	PAM3	PAM3	PAM4
Communication Method	Half-duplex transmission Full-duplex transmission (optional)	Full duplex transmission	Full duplex transmission	Full duplex transmission
Topology	Peer to Peer Multidrop	Peer to Peer	Peer to Peer	Peer to Peer

*2:DME: Differential Manchester Encoding

Summary

The automotive networks connecting ECUs and other devices for next-generation, fully-automated driving vehicles are attracting a great deal of attention. The automotive Ethernet has different standards for each transmission speed. TDK offers common mode chokes and chip varistors for each of these standards. In particular, our ACT1210E-241-2P product is optimized for 10BASE-T1S with a transmission speed of 10 Mbps, which is the new standard for automotive Ethernet.

Contact Information

Inquiries on products, sales, or technical matters

Related Links

Product Portal

Common Mode Filters / Chokes product Information
A comprehensive guide to information on Common Mode Filters / Chokes from the TDK Group.

Chip Varistors / Ceramic Transient Voltage Suppressors product Information
A comprehensive guide to information on Chip Varistors / Ceramic Transient Voltage Suppressors from the TDK Group.