

EMI suppression in the fast lane



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Ethernet is quickly becoming the networking protocol of choice for high-speed multimedia infotainment applications in cars. The range of new TDK common-mode chokes for automotive bus systems such as CAN, FlexRay, and Ethernet not only offer the best noise suppression performance, but are often the world's smallest as well.

As satellite navigation systems, multimedia entertainment systems, and advanced driver assistance become more commonplace in vehicles, the demands on the automotive bus systems are rising, especially in terms of data rates. CAN, which offers data rates of up to 1 Mbit/s, is the established bus system for networking the control units of power locks, seats, lights, air-conditioning, and dashboard instruments. FlexRay, with its speeds of up to 10 Mbit/s, is well suited for the networking of safety and powertrain applications such as ABS systems, electric power steering, and transmission and engine control units (Figure 1).

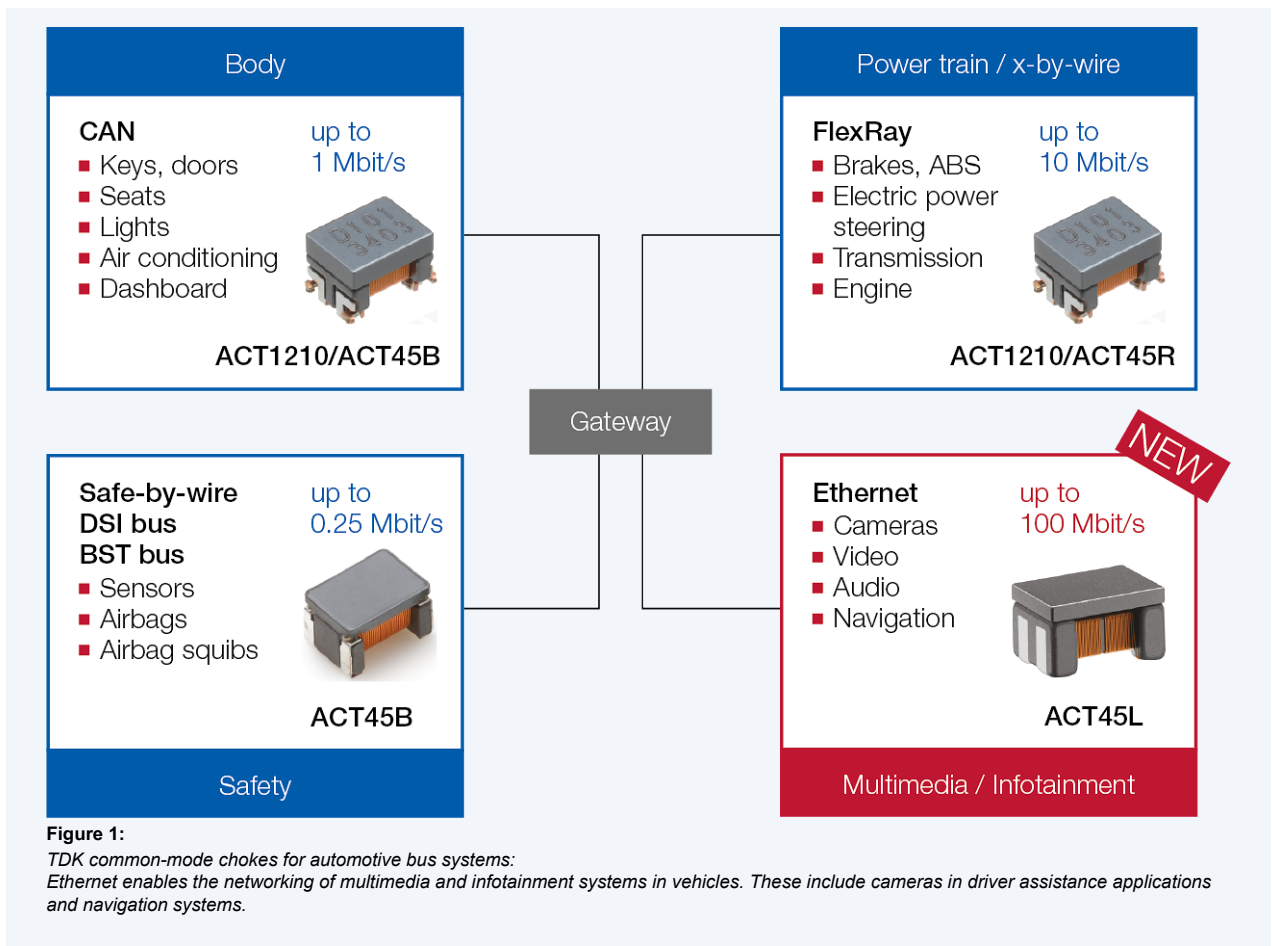


Figure 1:

TDK common-mode chokes for automotive bus systems:

Ethernet enables the networking of multimedia and infotainment systems in vehicles. These include cameras in driver assistance applications and navigation systems.

These automotive bus systems, however, were not designed to support the high data rates needed for the emerging multimedia infotainment applications. Furthermore, the wide variety of networking systems currently in use are essentially network islands, each with its own cabling and control system and unable to interoperate. Ethernet offers carmakers the advantage that it can function as a backbone for a network of networks and thus enable more elegant network architectures.

For these reasons, many of the world's leading carmakers and automotive electronics suppliers are promoting Ethernet-based networks as the connectivity standard in automotive networking applications. Ethernet, of course, is already the firmly established networking protocol for computers, peripherals, communication devices, and multimedia.

Scalable networking up to 100 Mbit/s

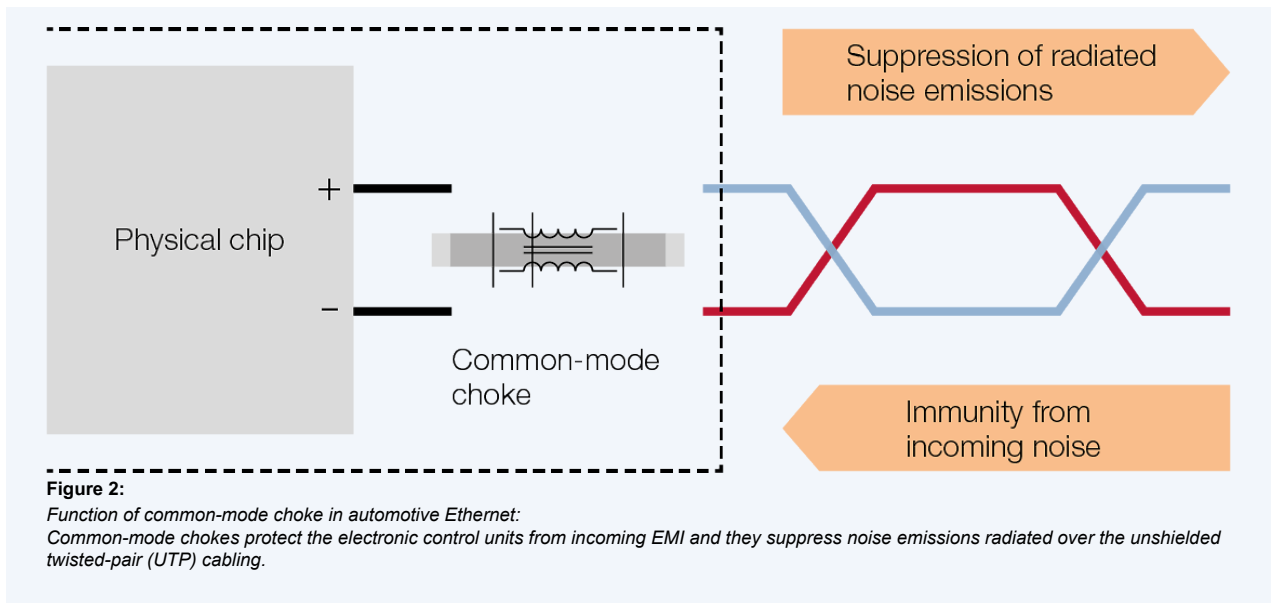
Ethernet, which supports data rates of up to 100 Mbit/s, is quickly becoming the networking protocol of choice for multimedia infotainment applications in cars. Ethernet is already being used for some diagnostics applications in automobiles. Moreover, Ethernet enables scalable solutions as the bandwidth needed for in-car networking continues to grow. After all, future cars will not only be expected to offer high-quality camera technology for lane changing, but will also have to support smartphones and tablets that are communicating at high speeds via WLAN, UMTS, and LTE connections.

As more and more applications and devices are networked in cars, OEMs are also turning their attention to the size and weight of the cabling. A particularly attractive feature of automotive Ethernet is the fact that it employs lightweight unshielded twisted-pair (UTP) wires. With automotive Ethernet, carmakers will be able to significantly reduce the size and weight of in-vehicle cabling, and thus improve the energy efficiency of vehicles.

EMC challenge

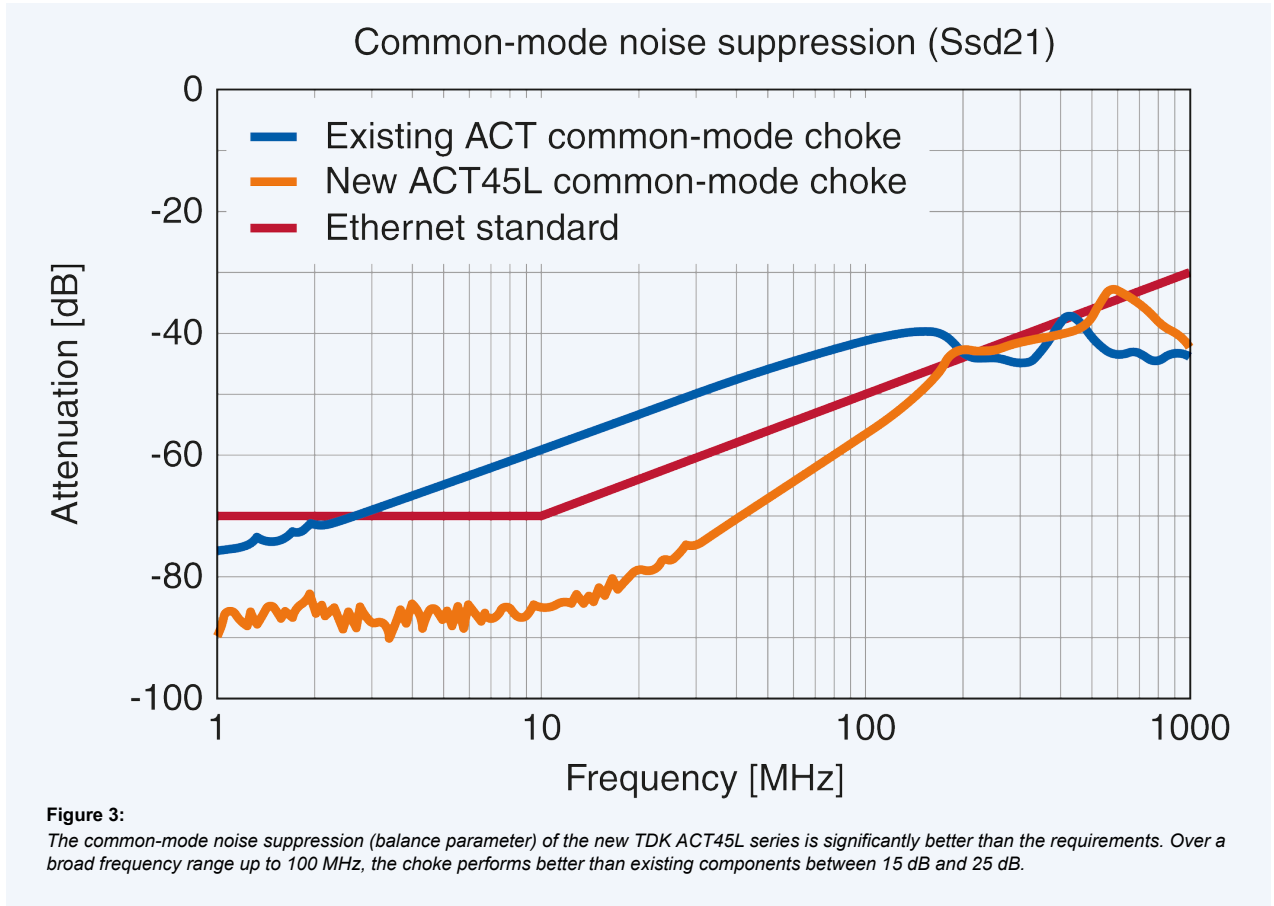
Suppression of EMI has become a major concern in the transmission, reception, and processing of electronic signals and data. Automotive Ethernet interconnects the functional blocks of modern systems via cables or wiring harnesses with very high signal speeds. Reliable high-speed data transmission, however, requires high noise suppression and, at the same time, low attenuation of the data signals. In addition, the UTP cabling requires special EMC measures. Therefore, the specifications of the new automotive Ethernet standard are significantly more demanding than the requirements of CAN and FlexRay with regard to common-mode noise suppression.

This task is handled by common-mode chokes positioned at the I/Os of the control units. They are necessary both to suppress radiated noise emissions from the physical chip of the control unit as well as to protect the chip from incoming noise (Figure 2).



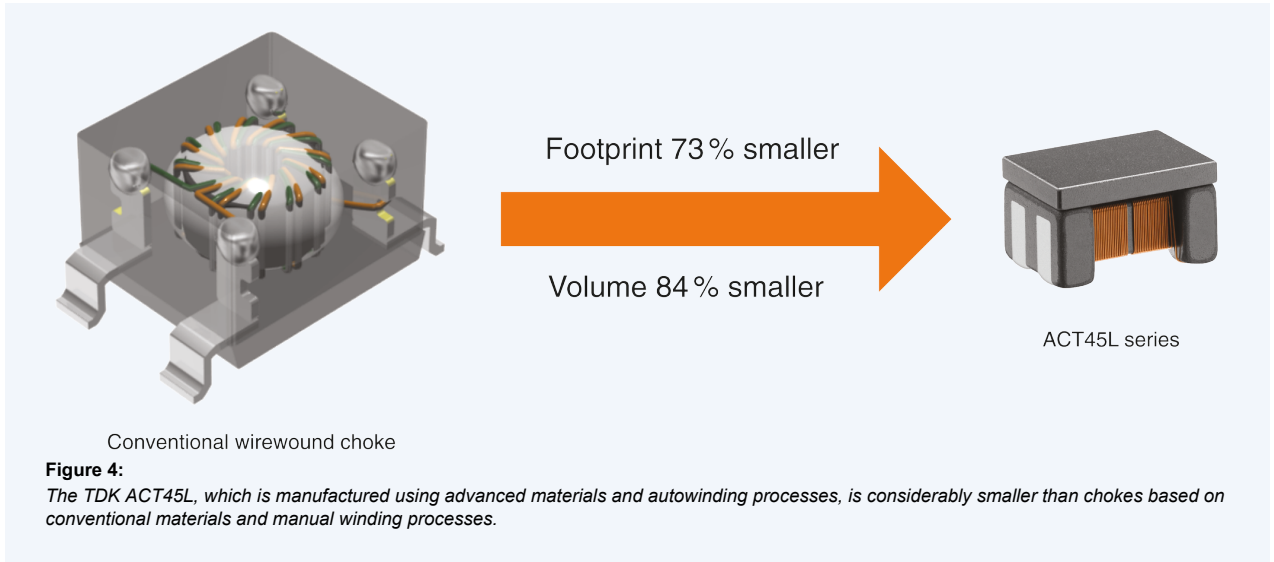
Superior common-mode noise suppression

In order to fulfill the stiffest requirements of automotive Ethernet, TDK has extended its market leading ACT series of common-mode chokes for automotive signal lines with the new ACT45L series, which features today's best common-mode noise suppression. The higher the attenuation of the noise is, the better the performance of the common-mode choke. Thanks to TDK's advanced technologies, the noise suppression of the ACT45L is between 15 dB and 25 dB better than existing products over a broad frequency range up to 100 MHz (Figure 3). The new series offers a rated inductance of 200 μ H and can operate in a broad temperature range from -40 °C to $+105$ °C.



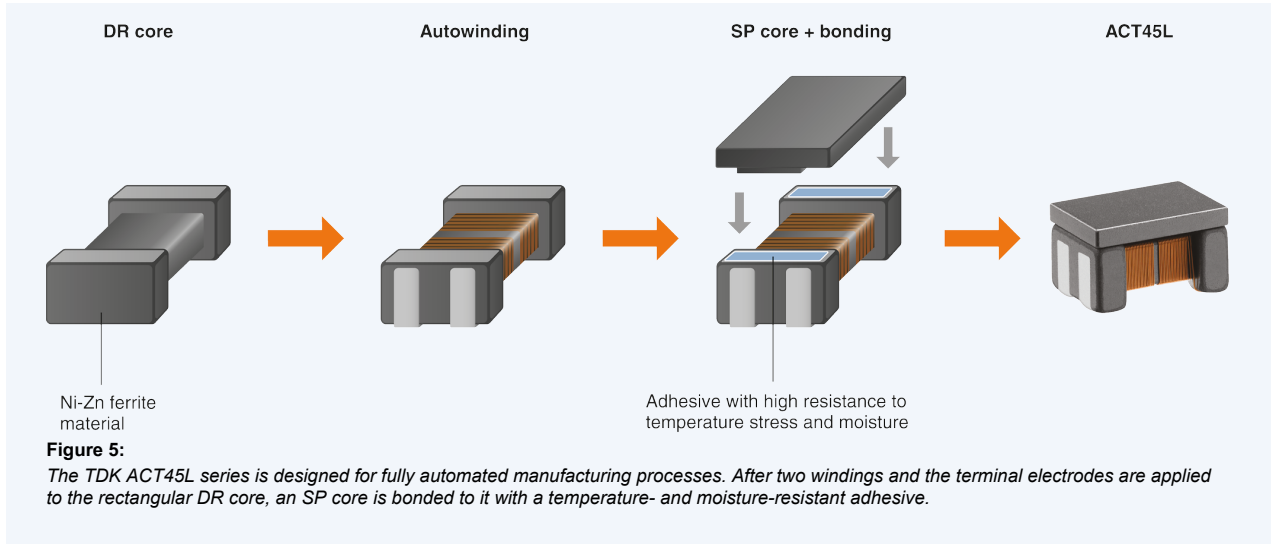
World's smallest common-mode choke for automotive Ethernet

Measuring in with a footprint of 4.5 mm × 3.2 mm and an insertion height of just 2.8 mm, the miniaturized ACT45L series is the smallest common-mode choke now available for automotive Ethernet. Compared to existing technologies, the size of the new choke's footprint has been reduced by 73 percent and its volume by a full 84 percent (Figure 4).



Designed for fully automated production processes

The new ACT45L series is designed to be manufactured using fully automated processes (Figure 5). The starting point for the components is a coil carrier with a rectangular profile (DR core) based on a Ni-Zn ferrite material. Next, two autowindings and the terminal electrodes are applied to the core. In the final step, a ferrite plate (SP core) is bonded to the DR core with a highly temperature- and moisture-resistant adhesive in order to close the magnetic circuit. The result is a new series of automotive components with high reliability and consistent quality that are qualified to AEC-Q200.



Complete portfolio of chokes for automotive bus systems

The new product is a member of TDK's growing and highly versatile lineup of high-performance EMC components for automotive networks (Table). Most recently, TDK enhanced the existing ACT45B and ACT45R series of common-mode chokes for CAN and FlexRay, respectively, with the miniaturized ACT1210 series for both CAN and FlexRay. With compact dimensions of just 3.2 mm × 2.5 mm × 2.4 mm, the chokes are the world's smallest. Their footprint is approximately 45 percent smaller than that of existing components, while their volume has been more than cut in half. They are rated for a wide operating temperature range from -55 °C to +150 °C.

Table: Portfolio of TDK common-mode chokes for automotive bus systems

| Series | ACT45L (NEW) | ACT45R | ACT45B | ACT1210 (NEW) |
|----------------------------------|---------------------|---------|--------------|-----------------|
| Application | Automotive Ethernet | FlexRay | CAN | CAN / FlexRay |
| Dimensions [mm] | 4.5 × 3.2 × 2.8 | | | 3.9 × 2.5 × 2.5 |
| Common-mode impedance [Ω] min. * | 10000 *** | 2200 | 300 to 2000 | 300 to 2200 |
| Common-mode inductance [μH] ** | 200 | 100 | 11 to 100 | |
| DC resistance [Ω] max. | 4.5 | 1.5 | 0.6 to 2.0 | 0.4 to 1.5 |
| Insulation resistance [MΩ] min. | 10 | | | |
| Rated current [mA DC] max. | 100 | 0.2 | 0.15 to 0.25 | 150 to 300 |
| Rated voltage [V DC] max. | 50 | | | 80 |

* at 10 MHz

** at 100 kHz (+50/-30 percent)

*** reference value, not specified