Achieving correct ESD protection for CAN FD

Connectivity, autonomous driving, and electrification are driving the evolution of automotive wiring harnesses. This results in a growing demand for high-speed data transmission and bandwidth required for ADAS. All of these must be protected from ESD spikes and surges.

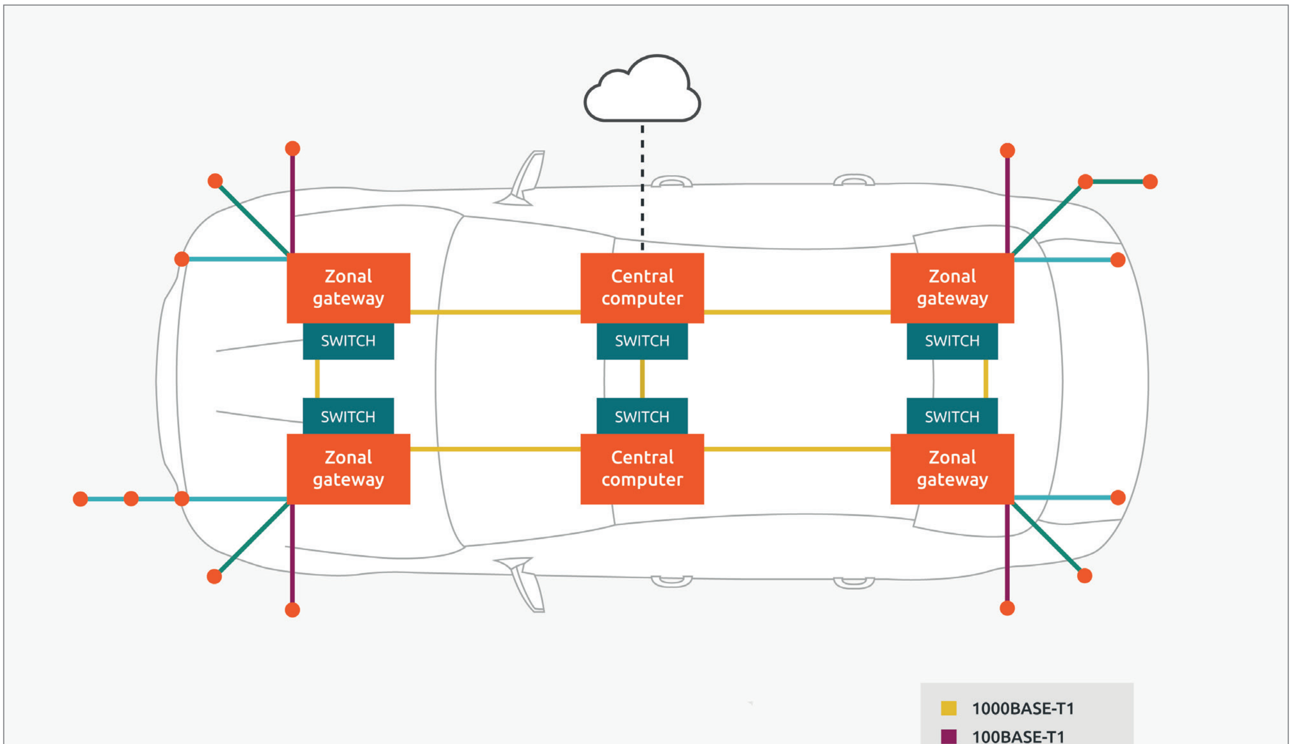

Figure 1: Zonal architecture of in-vehicle network (Source: Nexperia)

Expectations surrounding travel and human interaction with vehicles are changing dramatically. The mega-trends of increased connectivity, autonomous driving, and electrification are driving the evolution of automotive wiring harnesses and fueling the growing demand for high-speed data transmission and bandwidth required for advanced driver-assistance systems (ADAS). Protection of ESD (electrostatic discharge) spikes and surges is essential.

Traditional wiring looms and in-vehicle networks have been undergoing a significant transformation. The classic flat architecture wiring harness is changing to a domain and zonal architecture (Figure 1) with Automotive Ethernet as the backbone. However, peripheral buses still need to transmit more data, so new versions of existing protocols are finding their way into vehicle networks. The CAN network is synonymous with in-vehicle networks but was limited to 1 Mbit/s until the launch of CAN FD, which covers speeds up to 12 Mbit/s and offers critical advantages necessary for future ADAS (advanced driver assistance systems) applications.

2 Mbit/s is the typical implementation limit suitable for many applications that do not require higher data rates. CAN FD uses the same differential signal levels as Classical CAN. The increased data rate is achieved by shortening the dominant and recessive states of a 'send' ▷

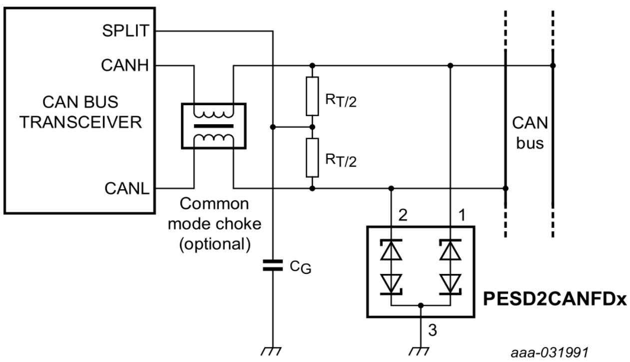

Figure 2: Circuit diagram showing Nexperia's improved PESD2CANFDx ESD protection diode in a CAN FD application (Source: Nexperia)

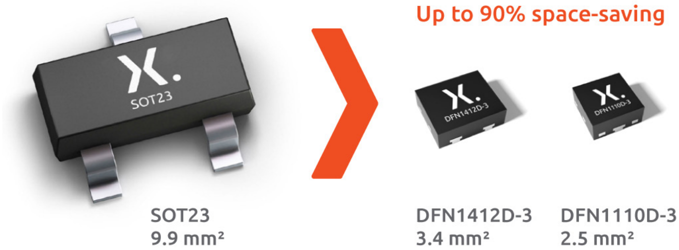

Figure 3: Leadless DFN packages reduce PCB space (Source: Nexperia)

frame. This technique increases the requirements on the physical layer and, as systems become more sensitive with regards to EMC (electromagnetic compatibility) and ESD, this requires additional, discrete ESD protection to improve system ESD robustness to a reliably acceptable level.

Besides OEM (original equipment manufacturer) car makers' requirements, ESD protection devices must fulfil automotive industry standards such as IEC 61000-4-2 and ISO 10605. For Classical CAN and CAN FD, ESD devices must be short-to-battery and jumpstart robust according to ISO 16750-2 (26 V) or internal norms (28 V). Compliance with IEC 62228-3 in combination with a CAN transceiver (emission, immunity: DPI, pulses, ESD) is also necessary. In addition, common requirements for CAN are diode capacitance of 17 pF to 30 pF and for CAN FD 6 pF to 10 pF, as the data speed is greater and signal integrity, as well as capacitance matching are more critical. Therefore, Nexperia has improved its IVN ESD protection diode product range and developed a new generation tailored to CAN FD requirements. The new PESD2CANFDx series comes in different voltage, capacitance, and packages configurations while being twofold AEC-Q101 qualified.

The advantages of leadless packages

Advantages of leadless CAN FD in DFN packages over classic SOT packages are not only significant PCB (printed circuit board) space savings but, especially, the improved signal integrity, which is critical for ESD protection. For signal integrity, routing is a crucial concern. Even though parasitic capacitance reduces the signal quality, at very low capacitances, the routing that is required to connect the package, plays an important role. The most important general conclusion agrees with best-practice signal integrity design: avoid switching layers; avoid using stubs.

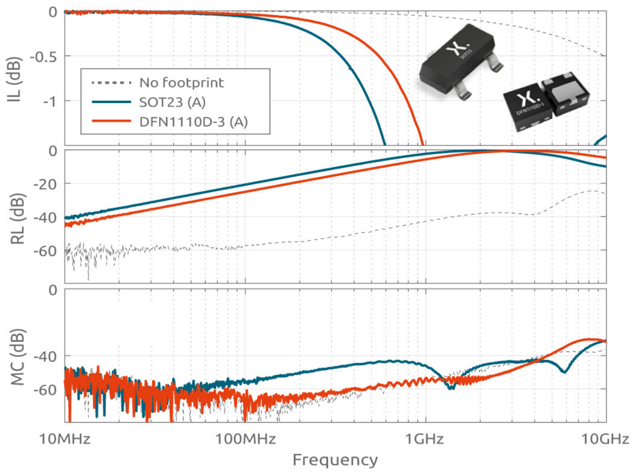

Figure 4: S-parameters comparison of no footprint, PESD2CANFD24V-T and PESD2CANFD24V-QB (Source: Nexperia)

S-parameters are a common way to measure the signal integrity. The parameters shown in Figure 4 are differential insertion loss (IL, S21dd), return loss (RS, S11dd), and differential to common mode conversion (MC, S21dc). The measurements were conducted using a VNA (vector network analyzer) and the system was calibrated to the probe tip, so the traces before and after the footprint are not de-embedded. Figure 4 shows the same routing schemes with a PESD2CANFD24V-T in SOT23 and PESD2CANFD24V-QB in DFN1110D-3, both with maximum diode capacitance of 6 pF. The dashed lines plot the results of straight traces without any footprint. It can be seen that the very similar performance of the empty footprints starts to deviate when devices are mounted. Here, the leads of the SOT23 package appear as stubs and the larger structure inside the package adds greater parasitics. As such, the DFN solution shows better signal integrity especially for insertion loss and common mode conversion compared to the leaded alternative. ◀

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