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in electronic design

Design For Electromagnetic Compliance In Ethernet Systems

With many appliances transitioning to Internet Protocol (IP) networks, the Ethernet interface finds itself in these products for the first time. This makes electromagnetic compliance (EMC) a challenge.

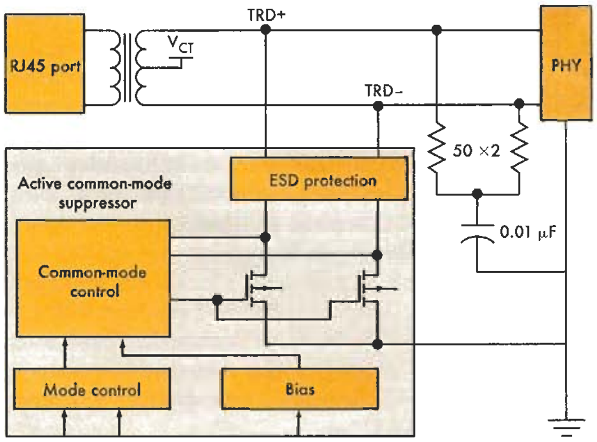
Ethernet's unshielded twisted pair (UTP) data-transmission cable acts as an antenna. Common-mode noise that leaks to it will show up as conducted or radiated emissions, creating unique electromagnetic interference (EMI) issues.

Another requirement is immunity to transient overvoltage and electrostatic discharge (ESD). The discharge of energy into submicron semiconductors can become destructive, especially in devices moving to 65-nm geometries. Traditional strategies for improving EMI/ESD performance involve discrete components, i.e., chokes, ferrite cores, and transient voltage suppressor (TVS) diodes.

These approaches impact Ethernet signal integrity, especially Gigabit Ethernet. Alternatively, by integrating system-level ESD and active common-mode suppression in one device, designers can address EMC issues early in the design cycle.

For EMI, the requirement has been FCC Class-A certification for enterprise class equipment and FCC Class-B certification for residential equipment, with FCC Class-B limits being 10 dB lower than Class-A. With Ethernet ports moving outside the enterprise, it is imperative to design Ethernet interfaces for FCC Class-B compliance. Addressing EMC issues late in the cycle incurs product re-spins and launch delays.

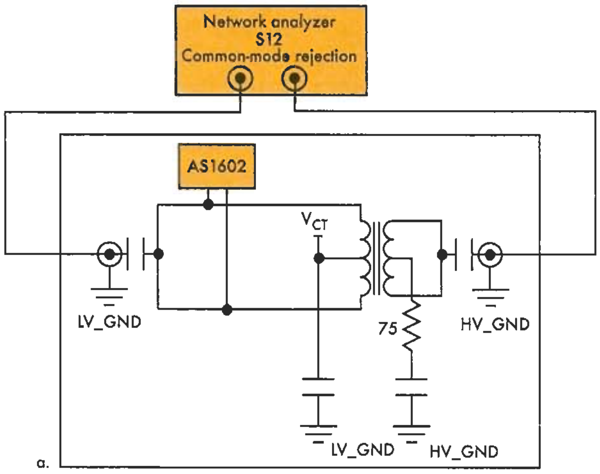
Emissions affecting Ethernet interfaces are usually due to common-mode noise. Energy has no return path on the cable, leading to the formation of a loop antenna. Imbalances in transmission-line length, capacitance, transmitter circuits, or passive components affect differential to common-mode signals, causing emissions.

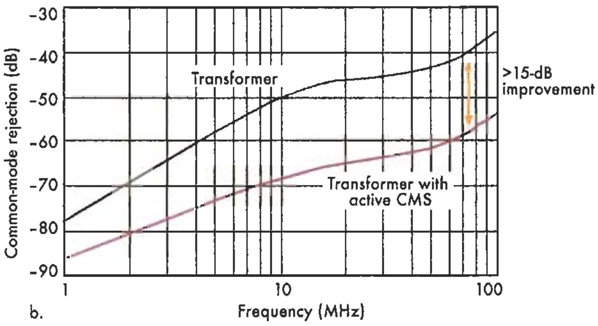


1. An active CMS circuit monitors positive and negative signals on the differential pair and shunts common-mode energy to ground.

In an active common-mode suppression (CMS) circuit, the CMS monitors positive and negative signals on the differential pair and shunts common-mode energy to ground by providing low impedance on transmit/receive data (TRD) lines while maintaining high differential impedance *(Fig. 1)*. The TRD signals convert to common mode only at the input of the CMS circuit. This conversion can achieve a matching accuracy of better than 0.1% via current design techniques.

This architecture prevents noise from physical-layer (PHY)/logic sides on the TRD from getting on the UTP cable. It also prevents noise on the UTP cable from getting to the PHY





2. Designers can use a variety of measurement setups to characterize CMRR performance (a). Test results show performance improvements provided by an active CMS device over a typical Gigabit Ethernet transformer (b).