



EMI Filtration for Gigabit Ethernet on Copper

For shorter cable lengths in gigabit ethernet applications, for instance in the office environment or in the server closet, the standard and most cost effective interconnection method is via multi-core copper wire. For longer cable lengths, say greater than 100m, multi-mode or single-mode optical fiber is the necessary transmission medium.

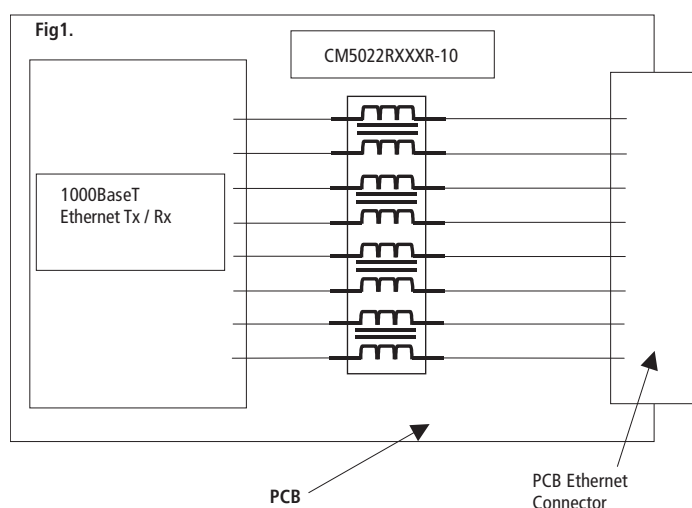
Due to the very high data rates (1000Mb/s or 1Gb/s) in gigabit ethernet on copper applications, coupled with high clock speeds and other peripheral high frequency circuitry, electro-magnetic interference can be a major concern on the UTP(unshielded twisted pair) cable connected to the ethernet port.

Application

Consider a 1Gb/s system, it has four pairs of UTP with each pair transmitting at 250Mb/s, thus giving an aggregate system speed of 1000Mb/s. The clock speed would be 125MHz with the rising and falling edge of the clock signal acting as trigger points. Emissions can be in the 40 MHz to 1 GHz frequency range. The source of the EMI can be the ethernet controller circuitry, other unrelated circuitry resident on the same board or circuitry on a separate board located in the same system as the ethernet circuitry. Other sources of EMI may be from a clock, a harmonic of a clock or wide band data noise.

The predominant mode of this EMI is common mode, i.e. common EMI signals of equal amplitude and phase are present on all or most of the PCB tracks giving concern. A solution to attenuate this EMI before it can couple onto the ethernet cable is to insert a multi-line common mode choke on the PCB, in line with the ethernet data prior to the ethernet PCB connector. Consider Laird Technologies' part series CM5022RXXXR-10, it is a range of 8-channel common mode choke arrays with impedance values of 80 ohms at 100MHz, 150 ohms at 100MHz and 200 ohms at 100MHz. The series is a range surface mount devices and are designed to be placed on the PCB and to be in-line between the ethernet transceiver to the PCB connector.

Figure 1 shows the placement of the CM5022RXXXR-10 on the PCB between the ethernet transceiver and the ethernet connector. The inclusion of such a device into the circuit should not affect or attenuate the actual gigabit ethernet signal. The inclusion of the choke into the circuit should only affect and attenuate the common mode EMI signals. The Laird Technologies' CM5022RXXXR-10 series of devices are designed to have minimal normal mode impedance. (Normal mode impedance is the impedance seen by the normal differential mode signal i.e. the data) On the other hand, the CM5022RXXXR-10 series are designed to have maximum common mode impedance in the EMI band of 40 MHz to 1 GHz. (Common mode impedance is the impedance seen by the common mode signal.)



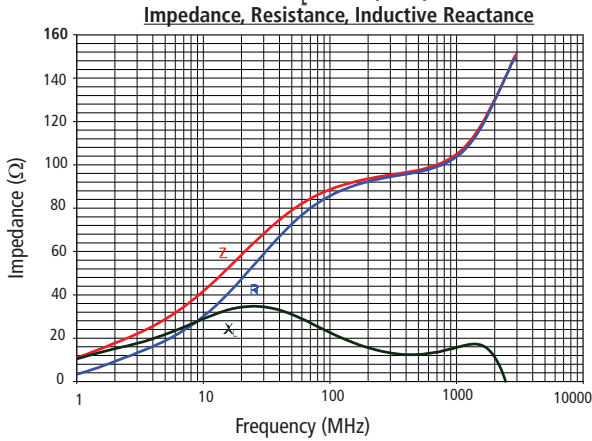
The following graphs detail the impedance, effective resistance and inductive reactance in the left hand column and open mode, common mode and normal mode impedance in the right hand column.

Normal Mode Impedance is the total impedance to the differential circuit (both out and back).

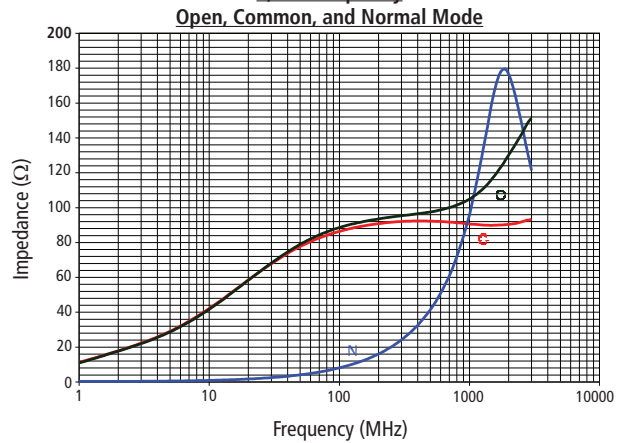
Open Mode Impedance is the impedance measured across a single leg of the common mode choke.

Common Mode Impedance is the impedance of seen by EMI noise conducted in the same direction along two conductors.

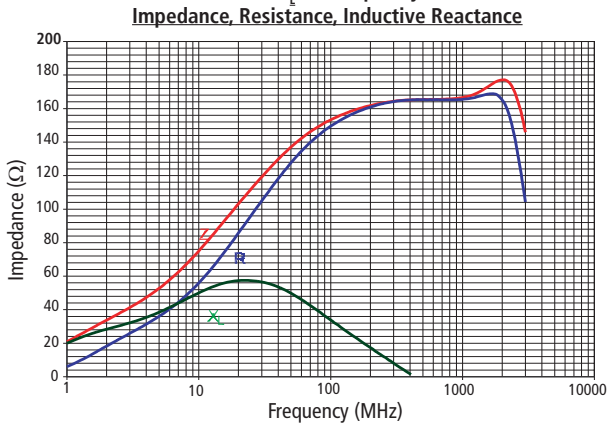
CM2722R800R-10, CM3822R800R-10, CM5022R800R-10
Z, R, X_L vs. Frequency



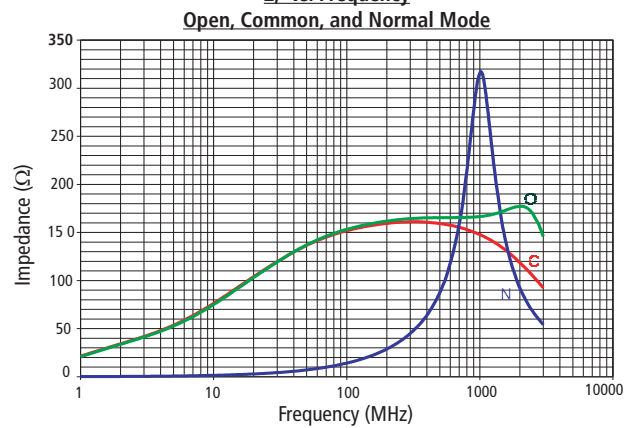
CM2722R800R-10, CM3822R800R-10, CM5022R800R-10
Z, vs. Frequency



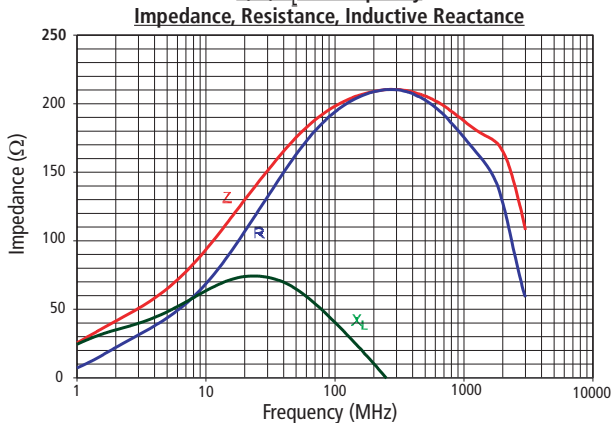
CM2722R151R-10, CM3822R151R-10, CM5022R151R-10
Z, R, X_L vs. Frequency



CM2722R151R-10, CM3822R151R-10, CM5022R151R-10
Z, vs. Frequency



CM2722R201R-10, CM3822R201R-10, CM5022R201R-10
Z, R, X_L vs. Frequency



CM2722R201R-10, CM3822R201R-10, CM5022R201R-10
Z, vs. Frequency

