LED Lighting Trends

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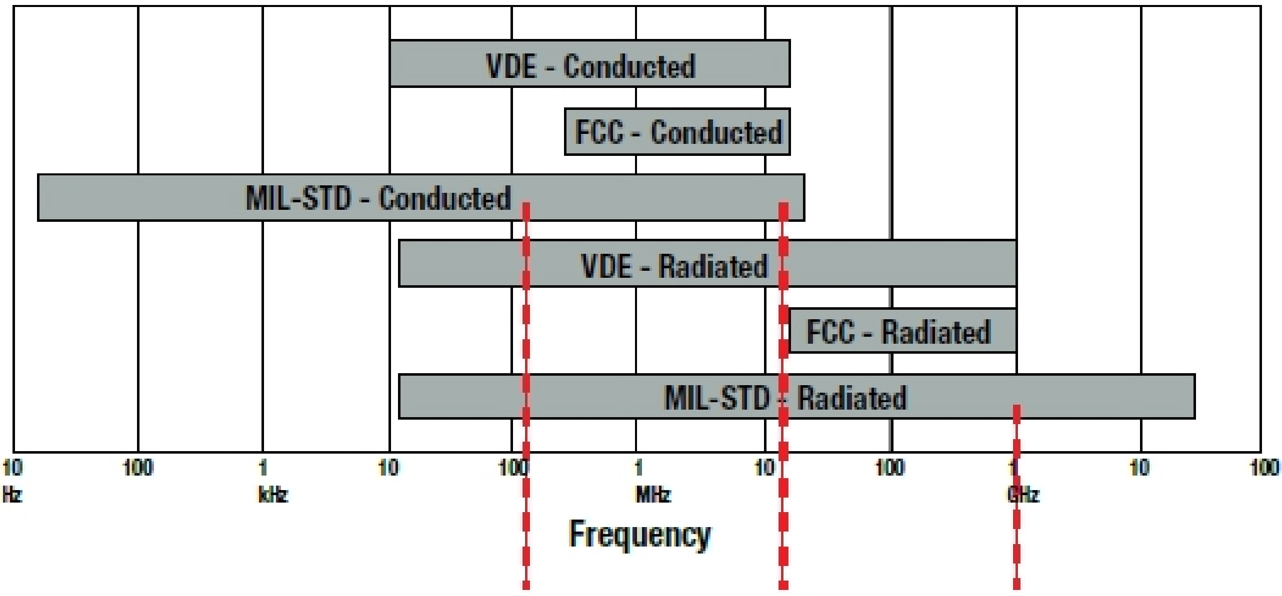
The lighting industry has experienced a rapid shift toward more energy-efficient products due to the marketing of “Green Products”, which focus on lowering the carbon footprint. The use of Light Emitting Diodes (LEDs) for replacement of standard incandescent light bulbs is more popular in residential and consumer lighting products. This transition is due to the success of LED lighting for traffic lighting, automotive lighting, and lower wattage industrial lighting.

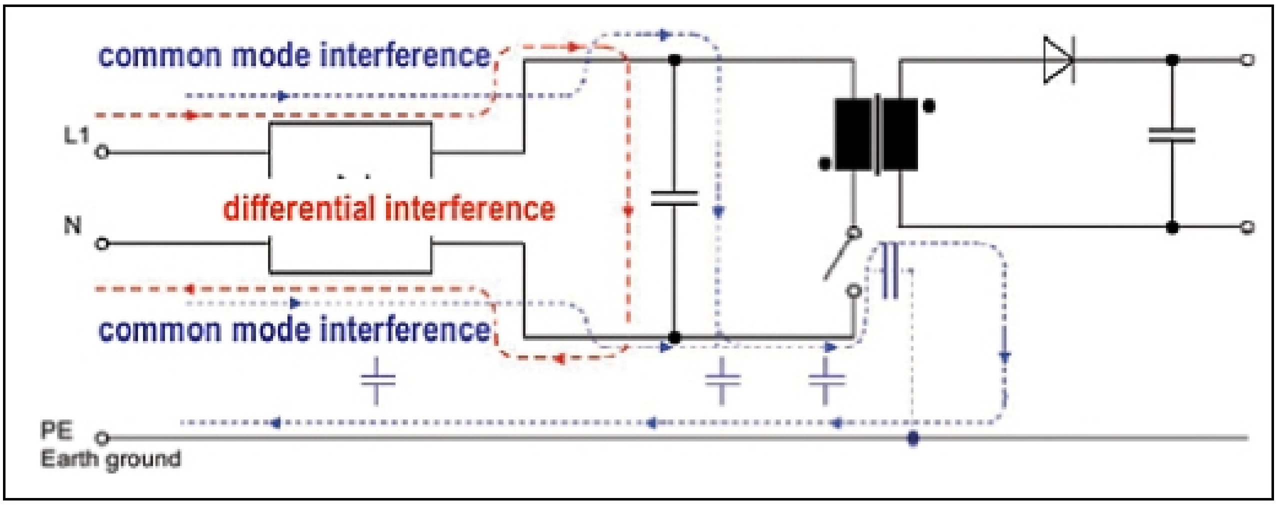
Any new innovation experiences obstacles. In LED lighting, one problem is the issue of Electromagnetic Interference (EMI), or unwanted noise signals. There are regulations and standards that govern the EMI levels for equipment classifications. Lighting products fall into a specific set of these classifications. This means that any lighting products using LEDs as replacement products for the standard incandescent light bulbs will need to meet EMI regulations.

LED lighting must be more aggressive to meet EMI, because driver circuits for the LED products operate at higher frequencies than the older incandescent bulbs (which operate directly off of the 50/60Hz line voltage). These higher switching frequencies are the culprit creating the EMI problems. For residential lighting, the unwanted interference occurs as either conducted or radiated signals. The conducted emission frequency ranges from 150 kHz up to 30MHz, and the radiated range is for frequencies of greater than 30MHz (See Figure 1 below). Even when the circuit designs are constructed and formatted to reduce EMI problems, there can be frequencies in those ranges that will not meet the minimum FCC regulatory standard level. When this occurs, there are different filtering devices or networks used to meet the EMI regulations.



If there are issues with radiated noise interference, the solutions shield certain components, or the entire circuit. Shielding the device blocks the unwanted signals, which are usually over 30MHz. The shielding is usually performed from copper shields to divert, or ferrite shields to absorb, the unwanted signals. The other failure is conducted noise interference. When conducted emission failures are detected, the problem is from differential mode (symmetrical) interference or common mode (asymmetrical) interference. As seen in Figure 2 below, differential interference occurs due to an unbalance of the current flow between the line (L1) and neutral (N) nodes. Differential noise appears from the out-phase voltages at these nodes from any unbalance of the signals. The voltage creates a current in these cables. This out of phase current is the differential current. When the signals are not equal and opposite, differential interference occurs.

Common Mode and Differential Mode Interference



The usual solution for correcting differential mode interference is to add an inductive component on each of the wires, one on the neutral and an equal value on the line. This employed solution will create impedances that will lower the unwanted signal. The differential mode current flowing in opposite directions through the added inductors will induce magnetic fields in opposite directions. This generates impedances, which will help to suppress the unwanted signal noise and better meet the regulatory maximum values. The other conducted interference type is common mode interference. This type of interference occurs from in-phase current flow between line (L1) and neutral (N) with respect to earth ground. All common mode interference develops when each current in the cable flows to earth ground via parasitic capacitance. The solution to lower this unwanted interference is to use a common mode inductor. This is a component that has two windings on a common core. By connecting the component properly in the circuit, the common mode current will flow in the same direction through each inductor winding; thereby, creating equal and inphase magnetic fields. This results in the part having high impedance to the common mode signal. Solutions using both common mode inductors with differential mode inductors are often used for reduction of the unwanted noise, while not losing much operating efficiency. Nevertheless, more circuit board space is needed, and cost increases in added components, but these methods need to be used to meet the FCC regulation levels.

Recognizing the need for a solution to this problem, Wurth Electronics Midcom set out to develop a lowcost, single component that would combine both a common mode and differential mode choke into one device. Utilizing the nature of stray magnetic fields in a coupled winding to our advantage, we were able to create a common mode choke which exhibited extremely high differential mode inductance as well. Further development of the part for the lighting industry lead to a low-cost part with superb performance and handily solves this problem Wurth Electronics Midcom has recently released the Dual Coil chokes, which have unsurpassed common mode and differential mode impedance for this small of a product. The electrical characteristics can be seen in Plot 1 for these new components, the Dual Coil series. From the
illustration in Plot 1, the differential mode impedance (DMZ) is seen to track very closely to the common mode impedance (CMZ). This will help to suppress the unwanted noise signals from each conducted mode, without need for additional magnetic components. The differential noise that occurs even at low frequencies in the kilohertz range can be lowered due to the high impedance values of the Dual Coil common mode inductor.

The understanding of both common mode interference and differential mode interference is important in order to correct EMI issues in an efficient and cost effective solution. As switching frequencies increase in order to increase operational efficiency and decrease driver sizes, the issues for interference also move into higher frequency bands. The lighting industry will continue to look for energy efficiency to replace the mature, but inefficient incandescent light bulbs. Over time, the more efficient, compact, fluorescent lamps and LED lighting circuits will continue to replace the standard incandescent bulbs. As this moves forward, the issues of EMI will be a concern, and solutions will need to be used to meet FCC and VDE regulations.

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