Power Line Common-mode Conducted EMI Emission: Myth Versus Reality (*)

The myth: Conducted EMI emission profiles are always attributable to conducted currents propagating from the product power connections to the Line Impedance Stabilization (artificial mains) Networks (LISNs)

The reality: Other systems effects can result in common-mode potentials measured at the LISNs as if they were propagated from the product power terminals.

Conducted EMI emission processes in power lines typically involves two characteristics of EMI: differential-mode; and, common-mode. Differential-mode currents emanating from power supplies in systems-products set up a line-to-line circulation of current. This current spectra then interacts with the series impedances of the LISNs to result in a differential-mode voltage spectra between the lines. Since the measurement of the conducted voltages (in dBuV) is typically single-ended to Earth reference, the differential-mode potential in the single-ended test is seen as one-half the value of the amplitude that is actually between the typical power pair.

Common-mode potentials are also measured in the single-ended process. These are superimposed upon any differential-mode spectra. Common-mode potentials typically circulate from both lines of the power pair at approximately equal levels in common-phase, as referenced to Earth. At frequencies below approximately 5 MHz, they may circulate from the power pair back to the earth safety wire. The current would be out of phase from the safety wire compared to the power pair. At frequencies above approximately 5 MHz, however, any interface connections to the product may become involved in common-mode circulations to the power pair. In effect, common-mode EMI emission FROM interface cable(s) can circulate through either direct-conducted or distributed impedance paths of Earth reference back to the power pair, and inversely, common-mode EMI from the power pair can circulate through to interface. When common-mode potentials sourced FROM the interface circulate to the power pair, the measurement effect may be seen as higher frequency narrowband voltages at the LISNs in power at “logic frequencies”.

To evaluate the propagation modes and separate the effects, use of current probes is effective. Differential-mode effects can be investigated by measuring the currents separately on each line of the power pair, then through the two together in the probe aperture. Differential levels will show some degree of cancellation with the pair combined compared to the amplitudes on either wire. Common-mode circulations between the pair that circulate to the Earth safety wire will show approximately equal currents from the pair (combined in the probe) to the safety wire separately, and will suggest a phase cancellation when the safety wire is combined within the probe with the pair. Conducted circulations that are sourced from the interface can be evaluated by placing the probe around the interface cable(s) at the frequency (or spectra) of interest, then comparing this profile to that displayed on the whole of the power cable. When the interface source effect occurs, the solution to narrowband emissions on the power cable may be found in shielding or otherwise suppressing the common-mode currents in INTERFACE rather than attempting to suppress the power entry (which may be futile, since that was not the source).

(*) Prepared by W. Michael King for publication in Elliott Laboratories’ Compliance Advisory Service Newsletter,