

Engineering / Physics Seminar

Wednesday 11/7/2007, 4:30 pm
Science & Engineering Building Auditorium

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What is “Partial Inductance”?

Clock and data speeds in digital systems have accelerated at astonishing rates in recent years. As “recent” as 20 years ago, clock speeds were on the order of 10MHz. The rise/fall times of the logic pulses were on the order of 50ns. Today, you can purchase a PC having a 3GHz clock and an “enormous” capacity hard drive for under \$500. In addition, the rise/fall times of the logic pulses are now in the sub-nanosecond range, e.g., 200 picoseconds. These digital logic signals today have frequency (spectral) content up to on the order of 15GHz. Ten years ago the conductors on the Printed Circuit Boards (PCBs) that carry these signals had no appreciable effect on those signals. Today the effects of these conductors on the signals they carry cannot be ignored and are becoming an increasingly severe problem in these high-speed digital systems.

An emerging area of concern in high-speed digital systems is “Signal Integrity” or SI. In order for these systems to function reliably and not “shoot themselves in the foot”, a pair of conductors must not corrupt the signal it carries from one point to another. If we input a digital signal to a pair of PCB lands, we expect the waveform that emerges from the other end to be the same shape as what was put in otherwise we will have logic errors and the system will not function. Today these SI problems due to the interconnect lands are becoming a serious problem. In addition, the PCB lands cause radiated emissions that can exceed the legal limits allowed by the Federal Communication Commission in which case the digital device cannot be legally sold in the US. We will discuss the critical SI issues of “ground bounce” and “power rail collapse” that cause a modern digital system to malfunction.

Inductance of the PCB lands is the primary cause of these SI problems. In order to understand and calculate the levels of the “ground bounce” and “power rail collapse” on these conductors, we must understand what is meant by “partial inductance”. This seminar will focus of how we can uniquely assign portions of the inductance of a current loop (a well understood concept for all engineers) to segments of that loop in order to understand “ground bounce” and “power rail collapse” in modern digital systems. These are called “partial inductances”.

Please join us for light refreshments at 4:15pm outside SEB 203.