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Why we seek to diminish RF energy in a PCB

In nearly every PCB there exists time-varying currents. Maxwell's equations describe the root cause of EMI. We will not elaborate on these equations yet we mention them here such that the reader can research them.
Time-varying currents produce both electric fields and magnetic fields. Further by Ohm's law V=R*I, when an RF current exists in a PCB trace and that trace has an impedance value, an RF voltage is produced which is proportional to the RF current. Impedance applies to both the Time domain and the Frequency domain.

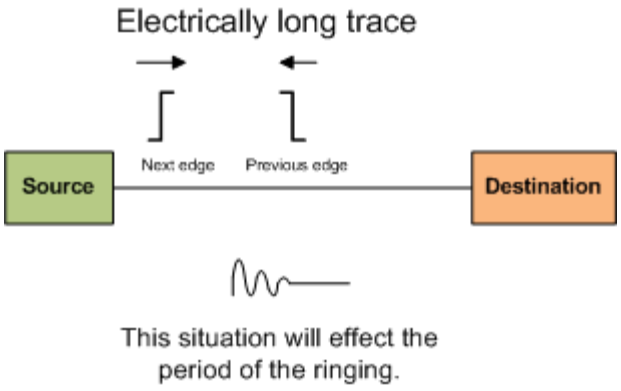


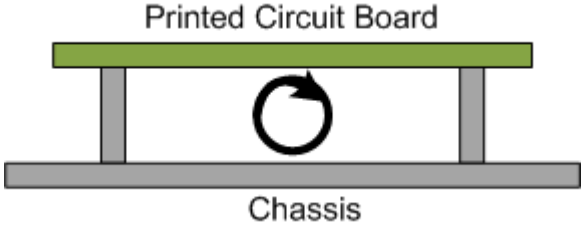
Figure 1

We see here in Figure 1 what happens when a signal line, or PCB trace, is “electrically long”. Without proper termination and trace length control your design will experience signal integrity problems.

Multipoint Grounding

Multipoint grounding will cause problems that most engineers overlook. This characteristic is found in the mechanical connection of a PCB to a chassis usually using screws. These mounting posts, the distance between them and the relative self-resonant frequency of the power and ground planes will induce “loop currents”. See Figure 2.

Figure 2



Note that these loops currents will couple to other PCBs, chassis housing, internal cables and harnesses, peripheral devices, connectors, or into free space via radiation or conduction.

Edge Rates

It behooves all designers to choose the slowest possible logic family. Of course you must maintain timing margins, but you cannot neglect your duty to minimize EMI and increase signal integrity.

Bypassing & Coupling

Bypassing and coupling are used to enhance power distribution and power quality. Decoupling augments constraints such as physical and time. It is required to assure proper operation of clock and data transitions during simultaneous switching with maximum capacitive loading. High frequencies in capacitors have increasingly low impedance.
There are 3 types of capacitors:

Decoupling:
Removes RF energy in power distribution networks. They also provide a local source of DC power and reduces peak current surges.

Bulk:
Augments stable DC rail voltages and current when the system or component experience simultaneous switching and capacitive loading. Helps to prevent rail sag due to dI/dt surges from local components.

Bypass:
Removes common-mode RF noise from components and cables. It also creates an AC shunt to guard suseptable components while providing limited filtering.

Proper Capacitor Selection

For edge rates of 2ns or less use a capacitor with a self resonant frequency if 10 to 30 MHz.
Use aluminum electrolytic for power supply and power line filtering.
Chose a capacitor that will suppress the third or fifth harmonic since this is where a majority of the RF current is found.
Always understand where your capacitors go self-resonant and become inductive!