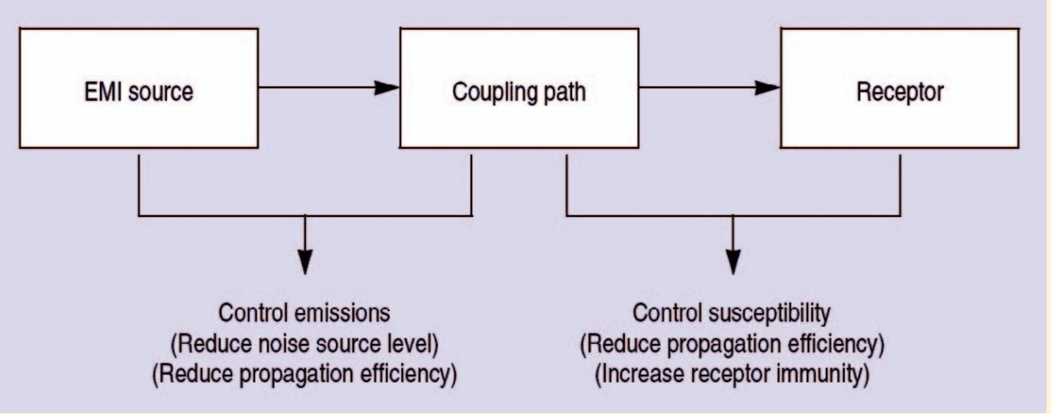
EMI

An Overview of EMI & EMC

This extract of an application note discusses the basics of board level electromagnetic interference (EMI) and electromagnetic compatibility (EMC).



Electromagnetic interference is a major problem in modern electronic circuits. To overcome the interference, the designer has to either remove the source of the interference, or protect the circuit being affected. The ultimate goal is to have the circuit board operating as intended – to achieve electromagnetic compatibility.

Achieving board level EMC may not be enough. Although the circuit may be working at the board level, but it may be radiating noise to other parts of the system, causing problems at the system level. Furthermore, EMC at the system or equipment level may have to satisfy certain emission standards, so that the equipment does not affect other equipment or appliances.

Many developed countries have strict EMC standards on electrical equipment and appliances; to meet these, the designer will have to think about EMI suppression – starting from the board level.

A simple EMI model consists of three elements, shown in the Figure above:

- EMI source
- Coupling path
- Receptor

EMI Source

EMI sources include microprocessors, microcontrollers, electrostatic discharges, transmitters, transient power components such as electromechanical relays, switching power supplies, and lightning. Within a microcontroller system, the clock circuitry is usually the biggest generator of wide-band noise, which is noise that is distributed throughout the frequency spectrum. With the increase of faster semiconductors, with faster edge rates, these circuits can produce harmonic disturbances up to 300 MHz.

Coupling Path

The simplest way noise can be coupled into a circuit is through conductors. If a wire runs through a noisy environment, the wire will pick up the noise inductively and pass it into the rest of the circuit. An example of this type of coupling is found when noise enters a system through the power supply leads. Noise carried on the power supply lines are conducted to all circuits.

Coupling can also occur in circuits that share common impedances. For instance, two circuits that share the conductor carrying the supply voltage and the conductor carrying the return path to ground. If one circuit creates a sudden demand in current, the other circuit's voltage supply will drop due to the common impedance both circuits share between the supply lines and the source impedance. This coupling effect can be reduced by decreasing the common impedance. Unfortunately, source impedance coupling is inherent to the power supply and cannot be reduced. The same effect occurs in the return-to-ground conductor. Digital return currents that flow in one circuit create ground bounce in the other circuit's return path. An unstable ground will severely degrade the performance of low-level analog circuits, such as operational amplifiers, analog-to-digital converters, and sensors.

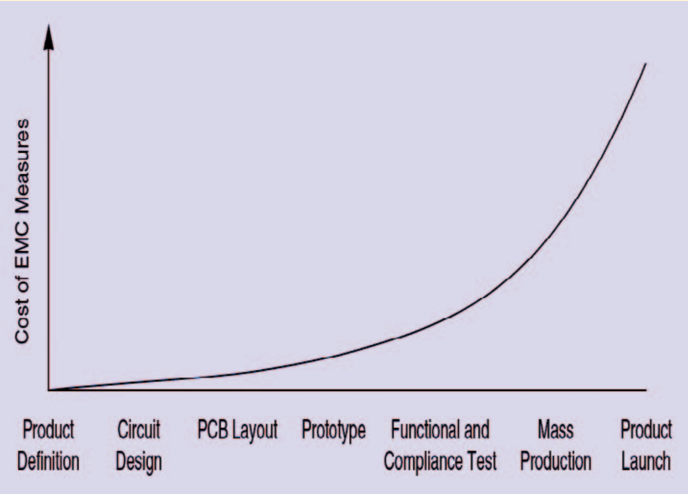
Coupling also can occur with radiated electric and magnetic fields which are common to all electrical circuits. Whenever current changes, electromagnetic waves are generated. These waves can couple over to nearby conductors and interfere with other signals within the circuit.

Receptor

All electronic circuits are receptive to EMI transmissions. Most EMI are received from conductive transients, although some are received from direct radio frequency (RF) transmissions. In digital circuits, the most critical signals are usually the most vulnerable to EMI. These include reset, interrupt, and control line signals. Analog low-level amplifiers, control circuits, and power regulators also are susceptible to noise interference.

To design for EMC and to meet EMC standards, the designer

Quelle:Freescale Semiconductor, Application Note AN2321, Designing for Board Level Electromagnetic Compatibility by T. C. Lun, Part 1 and Appendix A



Cost of EMC Measures

should minimize emissions (RF energy exiting from products), and increase susceptibility or immunity from emissions (RF energy entering into the products). Both emission and immunity can be classified by radiated and conductive coupling, as shown in Figure. The radiated coupling path will be more efficient in the higher frequencies while a conducted coupling path will be more efficient in the lower frequencies.

Cost of EMC

The most cost-effective way to design for EMC is to consider the EMC requirement at the early stages of the design (see second Figure).

It is unlikely that EMC will be the primary concern when the designer first chooses the components, designs the circuit, and designs the PCB layout. But if the suggestions in this application note are kept in mind, the possibility of poor component choice, poor circuit design, and poor PCB layout can be reduced.

Glossary of Terms

Electromagnetic Compatibility (EMC)

The capability of electrical and electronic systems, equipment, and devices to operate in their intended electromagnetic environment within a defined margin of safety, and at design levels or performance, without suffering or causing unacceptable degradation as a result of electromagnetic interference (ANSI C64.14-1992).

Electromagnetic Interference (EMI)

The lack of EMC, since the essence of interference is the lack of compatibility. EMI is the process by which disruptive electromagnetic energy is transmitted from one electronic device to another via radiated or conducted paths (or both). In common usage, the term refers particularly to RF signals. EMI can occur in the frequency range commonly identified as “anything greater than DC to daylight”.

Radiated Emissions

The component of RF energy that is transmitted through a medium as an electromagnetic field. RF energy is usually transmitted through free space; however, other modes of field transmissions may occur.

Conducted Emissions

The component of RF energy that is transmitted through a medium as an propagating wave, generally through a wire or interconnect cables.

Immunity

A relative measure of a device or a system’s ability to withstand EMI exposure while maintaining a predefined performance level.

Electrostatic Discharge (ESD)

A transfer of electric charge between bodies of different electrostatic potential in proximity to each other or through direct contact. This definition is observed as a high-voltage pulse that may cause damage or loss of functionality to susceptible devices. Although lightning differs in magnitude as high-voltage pulse, the term ESD is generally applied to events of lesser amperage and more specifically to events triggered by human beings.

Radiated Immunity

A product’s relative ability to withstand electromagnetic energy that arrives via free-space propagation.

Conducted Immunity

A product’s relative ability to withstand electromagnetic energy that penetrates it through external cables, power cords, I/O interconnects, or chassis. EMI may couple to a chassis, if interconnects are improperly implemented.

Susceptibility

A relative measure of a device or system’s propensity to be disrupted of damaged by EMI exposure to an incident field or signal. It is the lack of immunity.