Electromagnetic Compatibility (EMC) and Electromagnetic Immunity (EMI)

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Electromagnetic Compatibility (EMC) is used to describe how well a device can function in its EM environment without causing any unwanted effects to the surrounding equipment. Electromagnetic Interference (EMI) is a result of electric or magnetic fields acting on the device causing it to malfunction. The absence of EMI in a system is called EMC. EMI can be due to all types of signals such as DC, AC, RF etc.

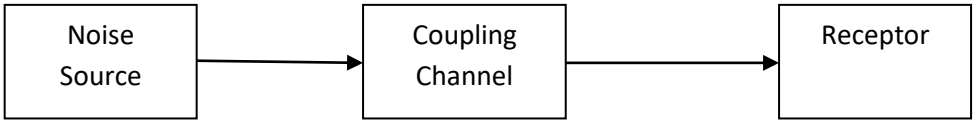
The sources of interferences (noise) can be categorized as Continuous Interference and Transient Interference. Continuous Interference arises when the source continuously emits at a given range of frequencies. According to the frequency range, they are sub divided into

- Audio frequency
- Radio frequency
- Broadband

Pulse or transient interference arises when the source emits pulse of energy for a short duration. Sources include

- Electro Static Discharge (ESD)
- Lightning

The first step in an EMC system analysis includes identifying the noise source, the susceptible receptor and their coupling channel. By changing the noise characteristics at the source such as changing the amplitude & frequency of the signal, the receptor problem can be solved. The immunity of the receptor can be improved by proper grounding and breaking the coupling path by using filters, shields, common mode chokes etc.



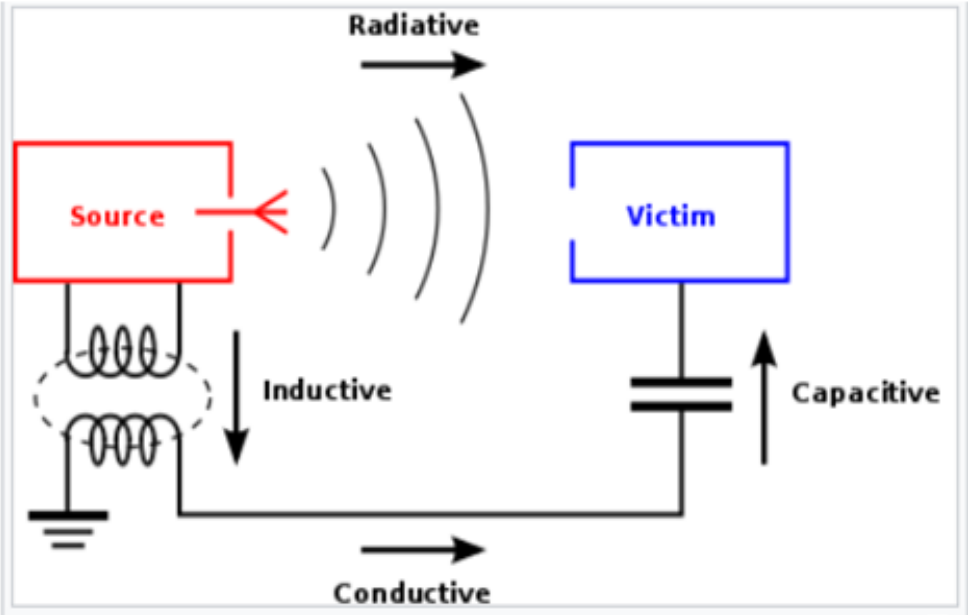
There are different EMI coupling mechanisms namely:-

(a) Conductive: This occurs mainly when there is a conductive route along which the signal can travel e.g. Power cables.
    - Common mode: In this type of coupling, the signal & noise are in the same phase on the conductors.
    - Differential mode: This occurs when the signal & noise are out of phase on the conductors.

(b) Inductive coupling
    - Capacitive coupling: When a varying voltage induces charge (energy) to the victim circuit.

- Magnetic coupling: When a varying magnetic field exists between the source & the victim e.g. two conductors running close to each other.

(c) Radiative coupling: This type of coupling exists when the source & victim are separated by a large distance typically more than a wavelength. The source radiates a signal which may be wanted or unwanted by the victim & disrupt its performance.



By determining the type of coupling that exists between the source & victim, the EMC performance can be optimized at the design stage by ensuring the precautions mentioned below.

Circuit design for minimum radiation: -RF radiated emissions arise from cables carrying high frequency signals, possibly data, and this can present some challenges in terms of improving their EMI /EMC.

EMC Filters: - Filters can be provided in the power circuits. EM filters will remove the high frequency components leaving low frequency elements which will not radiate much. This may however cause loss of data.

Circuit partitioning: - This basically involves segregating into EMC critical and non critical areas. High frequency circuits, low level analogue circuits and high speed switching (logic) circuits are categorized as EMC critical. Non critical areas are circuits including SMPS, slow speed circuits. The critical areas, which contain sources of radiation, are provided with filters or screens to prevent EMI being radiated.

Grounding:-For any system, the grounding scheme considered is of importance for its EMC performance. Poor grounding system can lead to ground loop currents which in turn can lead to signals being radiated within the system and hence poor EMC.

Screened Enclosures:- Placing the device in a screened enclosure that is grounded will significantly improve the performance.

Screened lines and cables: -Screened cables should be considered to prevent any radiation from the signals being carried or the pickup of any noise from external sources.

By adhering to above precautions, the EMC performance of the circuit can be generally enhanced. However, EMC testing will ensure that the equipment meets the desired performance.

EMC/EMI testing is a critical step for any electronic device.

EMC testing can be grouped into two categories:

- Emissions testing – These tests measure the amount of electromagnetic noise generated by a device during normal operation. The purpose of these tests is to ensure that any emission from a device is below the relevant limits defined for that type of device. This, in turn, provides a reasonable assurance that the device will not cause harmful interference to other devices operating within its expected operating environment. The tests include

    - Conducted emissions
    - Radiated emissions

- Immunity testing –These tests measures how a device will react when exposed to electromagnetic noise and other disturbances. The purpose of these tests is to gain a reasonable assurance that the device will operate as intended when used within its expected operating environment. The tests include

    - Conducted Immunity
    - Radiated Immunity
    - ESD immunity
    - Transient immunity
    - Surge immunity

In various projects engineered by TCE the EMC / EMI compliance is achieved by implementing many of the above mentioned techniques as applicable.