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Electromagnetic Interference and Compatibility- A Review

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Abstract: **This paper express the review summary of the electromagnetic interference and compatibilitywhich is basically deals with the electrical engineering concerned with the unintentional generation, propagation and reception of electromagnetic energy which can cause the unwanted effects such as electromagnetic interference (EMI) or also physical damage in operational equipment. The purpose of EMC is the correct operation of various equipment in the common electromagnetic environment. In particulars EMC Design, EMC control, EMC testing methodologies is discussed.**

Keywords: **EMC Design, control of EMC, testing methodologies, LISN**

I. Introduction:

Radio frequency interference is a distortion occurred by an external source which affects an electrical circuit by electromagnetic induction, electrostatic coupling, or conduction. The disturbance may degrade the performance of that circuit or even stop it from working. In that case of a data path, these effects can range from rise in error rate to a total loss of the data. Both man-made and natural sources generate changing electrical currents and voltages that can cause EMI automobile ignition systems, mobile phones, thunderstorms, the Sun, and the Northern Lights. EMI certainly affects AM radios. Electromagnetic compatibility (EMC) is concerned with

the unintentional generation, propagation and reception of electromagnetic energy which may cause unnecessary effect such as electromagnetic interference (EMI) or even physical damage in operational equipment. The goal of EMC is the correct operation of different apparatus in a common electromagnetic environment.EMC pursues two main categories of issue. Emission is the generation of electromagnetic energ by some source and its release into the environment. EMC gives study about the unwanted emissions and the countermeasures which may be taken in order to reduce unwanted emissions. Firslty,compatibility is the tendency of electrical equipment, referred to as the victim, to malfunction or break down in the presence of unwanted emissions, which are also known as Radio frequency interference (RFI). Secondly, coupling is the mechanism by which emitted interference reaches the victim.Interference mitigation and hence electromagnetic compatibility can be achieved by addressing any or all of these issues, i.e. quieting the sources of interference, inhibiting coupling paths and/or hardening the potential victims. In practice, many of the engineering techniques used, such as grounding and shielding, apply to above all three categories of issues.

II. EMC design

Electromagnetic noise is produced in the source by the rapid currentand voltage changes, and spread via the

coupling mechanisms described above. There are many aspects of good EMC design practice apply equal to potential emitters and to potential victims as shown in Fig1. Further, a circuit which easily couples energy to the outside world will equally couple energy in and will be susceptible. For this purpose we can also use the device basically known as LISN or **Line Impedance Stabilization Network.**

LISN **(line impedance stabilization network)**is a device used in conducted and radiated radio-frequency emission and susceptibility tests, as specified in various Electromagnetic compatibility, the LISN is a low-pass filter typically placed between an AC or DC power source and the EUT (Equipment Under Test) to create a known impedance and to provide a Radio frequency (RF) noise measurement port. It also isolates the unnecessary RF signals from the power source. In addition, LISNs can be used to predict conducted emission for diagnostic and pre-compliance testing.

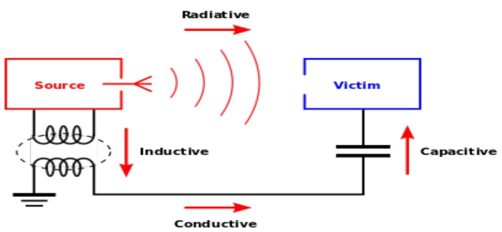

Fig1: Design of EMC

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Here as we can see in Fig.2 there are various frequency levels of emission or it can be easily analyzed the higher and the lower frequencies on which the emission is to be occurred.

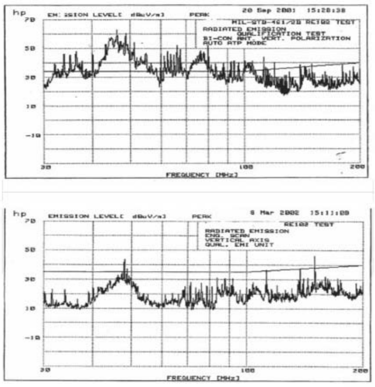

Fig2.Emission at different frequency levels

III. EMC control:

The damaging effects of electromagnetic interference pose unacceptable risks in many areas of technology, and it is necessary to control such interference and reduce the risks to acceptable levels.The control of electromagnetic interference (EMI) and assurance of EMC comprises a chain of related disciplines:

- 1. Characterizingof the threat.

2. Setting the standards for emission and susceptibility levels.

3. Design for standards compliance.

- 4. Testing for standards compliance.

Depending upon the Characterizing of the threat the Characterization of the problem requires understanding of:

- The interference sources and signals.
- The coupling path to victim.
- The nature of the victim both electrically and in terms of the significance of malfunction.

Most of the work in threat characterization and standards setting is generally based on reducing the probability of disruptive Electromagnetic Interference to the particular acceptable level, rather than its assured elimination.For a complex equipment, this may require the production of a dedicated *EMC control plan* summarizing the application of the above and specifying additional documents required.

IV. EMC Testing:

Testing is required to make sure that a particular device meets the required standards. It divides broadly into emissions testing and susceptibility testing.Open-air test sites, or OATS, are used as the reference sites. They are especially useful for emissions testing of large equipment systems.However RF testing of a physical prototype is most often carried out indoors, in a specialized

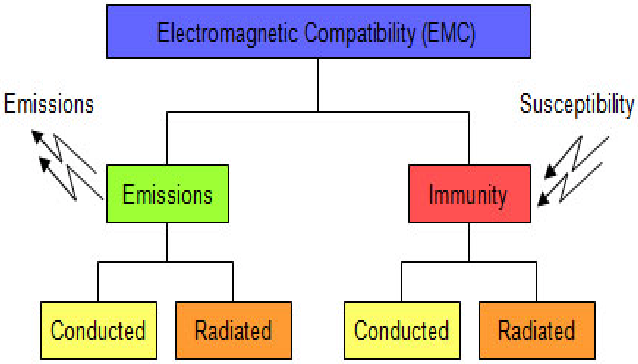

Fig3:EMC testing Methodologies

The Fig.3 shows the various EMC testing methodologies. EMC test chamber. Types of chamber include anechoic, reverberation and the Gigahertz Transverse Electromagnetic cell (GTEM cell).Sometimes computational electromagnetics simulations are used to test the virtual models. It is important that the test equipment, including the test chamber or site and any software used, be properly calibrated and maintained like all other compliance testings.Typically, the observed run of test for particular part of equipment will require an *EMC test plan* and follow-up *Test report*. The full test program may also require the production of several such documents.

V. Types of EMC Testing

EMC can be observe by using various methods of testing in which basically are:

Emissions testing:

Emissions are measured for radiated field strength and for conducted emissions along cables and wiring. Typically a spectrum analyzer is used to measure the emission levels of the DUT across a wide band of frequencies or we can sayfrequency domain. Specialized spectrum analyzers for EMC testings are available, called as EMI Test receivers or EMI Analyzers. These incorporate bandwidths and detectors as specified by international EMC standards. EMI receivers along with the specified given transducers can oftenbe used for both conducted and radiated emissions. Pre-selector filters may also be used to reduce the effect of strong out-of-band signals on the front-end of the receiver.For conducted emissions, typical transducers include the LISN (Line Impedance Stabilization Network) or AMN (Artificial Mains Network) and the RF current clamp.For radiated emission measurement, antenna can also be used as transducers. Typical antennas such asdipole, biconical, log-periodic, double ridged guide and the conical log-spiral or many other different designs. Radiated emissions must be measured in all directions around the DUT.Some of the pulse emissions are more usefull

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to characterized by using an oscilloscope to capture the pulse waveform in the time domain. The most widely used device is LISN for emission testing.Line Impedence Stabilization Network which is used in radio frequency emission and susceptibility as shown here in fig4.

Line Impedance Stabilization Network

LISN (line impedance stabilization network) is a device used in conducted and radiated radio-frequency emission and susceptibility tests, which are specified in various Electromagnetic compatibility (EMC)/EMI test standards (e.g., by CISPR, International Electrotechnical Commission, CENELEC, U.S. Federal Communications Commission, MIL-STD, etc.).

A LISN is a low-pass filter typically placed between an AC or DC power source and the EUT (Equipment Under Test) to create a known impedance and to provide a Radio frequency(RF) noise measurement port. It also isolates the unwanted RF signals from the power sources.In addition with, LISNs can be used to predict the conducted emission specially for diagnostic and pre-compliance testing.

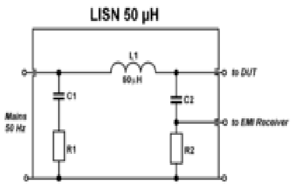

Fig4. Circuit Diagram of LISN

Radiated Emissions Test Method

As shown below Fig.5 reveals the electromagnetic waves don't extend out from the product in a nice spherical pattern.The emissions tend to be pretty directional, so a test lab has to vary the height of the receiving antenna between 1 and 4 meters as well as rotate a turntable.

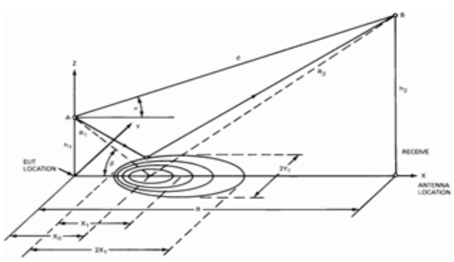

Fig5. Radiated Emission test Method

The receiving antenna picks up both the signal direct from the EUT, as well as a bounce off the ground. To increase the accuracy of measurement, the ground is covered with an electromagnetically reflective surface (aluminum, steel, wire mesh etc..) and this ground plane must be relatively flat.

The test lab will scan the frequency band of interest and look for emissions that are close to the limits. Using a process called as 'maximization' (described below), the test lab focuses in on each of these emissions, and quantifies the amplitude of the field strength.

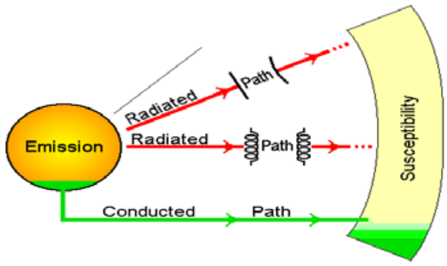

Fig6.Emission and Susceptibility testing

a. Susceptibility testing

As shown in fig.6 it shows that how both emission and susceptibility testing methods are related. Susceptibility testing of conducted voltage and current involves a high-powered signal and a current clampto inject the test signal.By using the immunity of transient to test the immunity of the DUT against powerline disturbances including surges, lightning strikes and switching noise.In motor vehicles, similar tests are performed on battery and signal lines. The above fig6. express the radiated emission.Electrostatic discharge testing is typically performed with a piezo spark generator called an "ESD pistol". High energy pulses like lightning can require a large current clamp or a large antenna which completely surrounds the DUT. Some of them antennas are so large that they located on outdoors, and care must be taken not to cause an EMP hazard to the surrounding environment.

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