One Day Seminar on "Electromagnetic Compatibility and Functional Safety"

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On 23rd April, the IEM Electrical Engineering Technical Division (EETD) has successfully organised a One Day Seminar on "Electromagnetic Compatibility and Functional Safety" at Wisma IEM. The speaker was Er. Prof. Dr. Lock Kai Sang from Singapore Institute of Technology.

Prof. Lock delivering his talk

EMC covers many areas such as power quality, surges, transient and lightning electromagnetic pulse. Electrical and electronic equipment are designed and built to operate satisfactorily under specified power quality and electromagnetic environment. They may malfunction or degrade in performance when operating beyond the stipulated power quality and electromagnetic environment. EMC describes the ability of electrical and electronic systems or components to function correctly together. In the case of mission-critical control and railway signalling equipment, functional safety depends on the system or equipment operating correctly in response to its inputs. Disastrous consequences may

occur if the input signals are corrupted by EMI. EMC standards are used to ensure adequate availability of equipment and system functionality with different standards developed to suit the wide variety of EM environment. Intentional EMI is an increasing security threat.

Electric and magnetic fields are produced whenever electricity is used. Electric field is produced by voltage whereas magnetic field is produced by current. At high frequencies, the electric and magnetic fields are coupled together in a particular relationship i.e. electromagnetic waves or radio waves. The atmospheric electric field at ground level is normally about 100V/m in fine weather. Faraday cage is a solution for electric field shielding which its coupling effect can be represented by a capacitor. Metallic shielding terminates electric field lines provided that it Is earthed. Yet, one should understand that metallic shielding is not sufficient to mitigate magnetic field. Magnetic field is also produced by the Earth itself. It is produced by current flowing in a conductor. Magnetic field coupling can be represented by mutual inductance.

What makes the various forms of electromagnetic fields to be so different is due to its different characteristic at different frequencies. Wavelength and frequency determine another important characteristic of electromagnetic fields. Electromagnetic waves are carried by particles called quanta. Static field and time-varying EMF were also briefly explained. IEC defines the EM environment as the totality of EM phenomena existing at a given location. Any electrical or electronic device creates what is called an electromagnetic environment as electrons are moved around to make the device work. EM environment may be man-made such as cabling and wiring systems, power systems, discharge0type lighting fixtures, MRT, medical equipment (X-ray), variable speed drives, electronic switching equipment, broadcasting transmitters, communication equipment, high altitude electromagnetic pulse, high power electromagnetic pulse, intentional electromagnetic interference, or natural phenomenon such as earth magnetic field, solar radiation, the universe and lightning.

Some of EM phenomenon is continuous such as voltage variations in AC and DC supplies, AC supply phase imbalance, harmonics of supply, AC ripple on DC supply. Transient EM phenomenon includes nuclear EM pulse, lightning and voltage dip.

A system or equipment is electromagnetically compatible if it:

1. Does not cause interference with other systems
2. Is not susceptible to emissions from other systems
3. Does not cause interference to itself

There should be a sufficient immunity margin between minimum immunity level and maximum permissible emission level. This margin should account for possible unsafe conditions which may result during abnormal operation.

IEC61000 series of EMC standards, in particularly Part 5, outlines the installation and mitigation guidelines.

There are several coupling mechanisms such as conducted EMI, common-mode impedance coupling, inductive coupling, capacitive coupling and radiated coupling. EMC coupling consist of source (emitter), medium (coupling path) and receptor (victim). Should you increase the shielding level of the emitter? Install an EMI filter? Properly shield the cable? Make the coupling path to be less efficient? Or should we raise the immunity level of the receptor? Early EMC management is always optimum.

Noise is an unwanted electric signal which will produce undesirable effect. Singapore Spectrum Allocation Chart was also shown by Prof. Lock. He then went on to explain the far field and near field phenomenon. Power system will be near field phenomenon. Common mode of coupling takes ground as the common reference whereas differential mode of coupling is between lines. Galvanic, inductive and capacitive coupling were also briefly explained by Prof. Lock.

Cables carrying high current have to be laid properly to reduce magnetic field interference as well as to address safety concerns arising from EM fields. Trefoil formation of 3 phase cables is better than flat formation as the former is susceptible to lower level of magnetic field. The “live/go” and “neutral/return” conductors of any circuit must always be placed as closed together as possible to minimise EMI. Screened and or twisted pair signal cables should be used for noisy and for sensitive circuits. Only conductors of the same group can be routed together in a cable or in the same bundle. In short, cable management which includes cable separation is essential.

EMI mitigations include cable system solution, shielding, earthing, filters, surge protection devices, bonding. Simple orientation of the distribution board may also alleviate the EMI threat. Next, Prof. Lock discussed on the significance of skin depth of common shielding materials. Shielding at lower frequency is more challenging due to skin depth.

Other than lecture, interesting activities whereby participants get hands-on experience with the latest power measurement equipment have also taken place immediately after the lunch break.

Demonstration on using a power measurement unit