ELECTROMAGNETIC INTERFERENCE

ELECTROMAGNETICS:

Electric and Magnetic forces are some of the original forces in the universe. These forces are important as we are affected by them almost every instant. Electromagnetism is the continued effect of electric and magnetic fields. Today's scientific development to a great extent is based on the electromagnetic fields, then propagation and varying effects under different boundary conditions. Electricity, telephone, radio, television, datalinks, medical, electronics, radar, remote sensing etc. are some of the vide application areas which have considerable impact on human life. The electric fields, which are produced by stationary or moving charges, are described by Maxwell's equations.

ELECTROMAGNETIC FIELDS:

James Clerk Maxwell established the fundamental equations of Electromagnetic Theory in 1873, based on

a) Faraday Induction Law.
b) Generalised Amperes Circuits Law.
c) Gauss's law for Magnetic & Electric fields.

The following equation was established.

$$\nabla . \overline{\Im}\ (\overline{r}, t) + \frac{\partial}{\partial f} \rho(\overline{r}, t) = 0$$

This is called the conservation law for electric charge and current densities.

$\overline{\Im}\ (\overline{r}, t)$ = electric current density (Ampere/m^2)

$\rho\ (\overline{r}, t)$ = electric charge density (Coulomb/m^3)

The Maxwell equations are fundamental laws governing the behavior of electromagnetic fields in free space and in media.

ELECTROMAGNETIC INTERFERENCE:

Electromagnetic interference is a phenomenon of unwanted electromagnetic signals, which may degrade the performance of an electronic device.

Electromagnetic interference is defined to exists when undesirable voltage or currents are present to influence adversely the performance of an electronic circuit or system. Interference can be within system (intera system), or it can be between systems (inter system). The system is the equipment or circuit over which one exercises design or magnetic control.

What are the causes of EMI?

Uncontrolled conductive path and radiated near/ far fields cause EMI. Fig. 1, 2 & 3 illustrates different path for causes of interference. The cause of an EMI problem is an unplanned coupling between a source and a receptor by means of transmission path.

Radiated interference

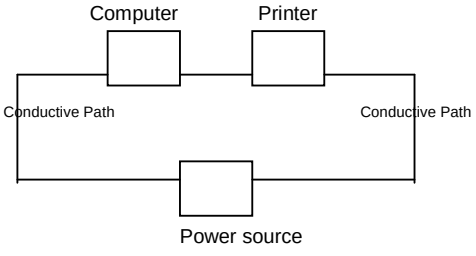


Figure –1

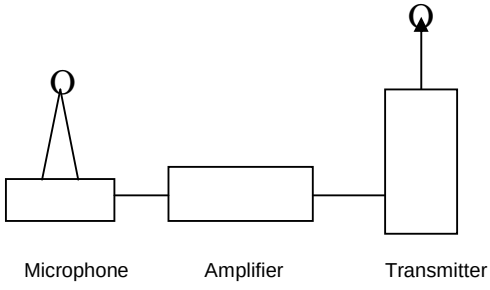


Figure – 2

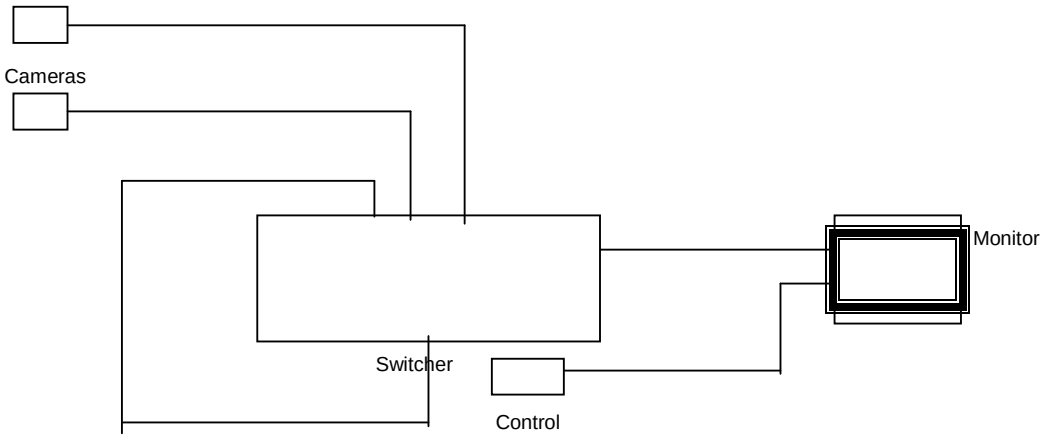


Figure – 3

What are the effects of EMI?

The Electromagnetic interference degrades the performance of electronic systems. EMI can be attributed to either intentionally or unintentionally generated electromagnetic energy. The purposeful generated electromagnetic energy for communication defined as intentionally generated EMI which has allowable limits as well as measurement techniques on Radio Frequency noise / interference has been set at national and international level.

CONTROL:

The control of Electromagnetic Interference is best achieved by good interference control principles during the design process. These involves selection of signal levels, impedance levels, frequencies and circuit configuration that minimize conducted and radiated interference. In addition, signal levels should be selected to be as low as possible, while being consistent with the required signal to noise ratio. Impedance levels should be chosen to minimize undesirable capacitive and inductive coupling.

Physically separated leads carrying current from different sources also achieve interference control.

For optimum control three major methods of EMI suppression, grounding, shielding and filtering should be incorporated in the design process.

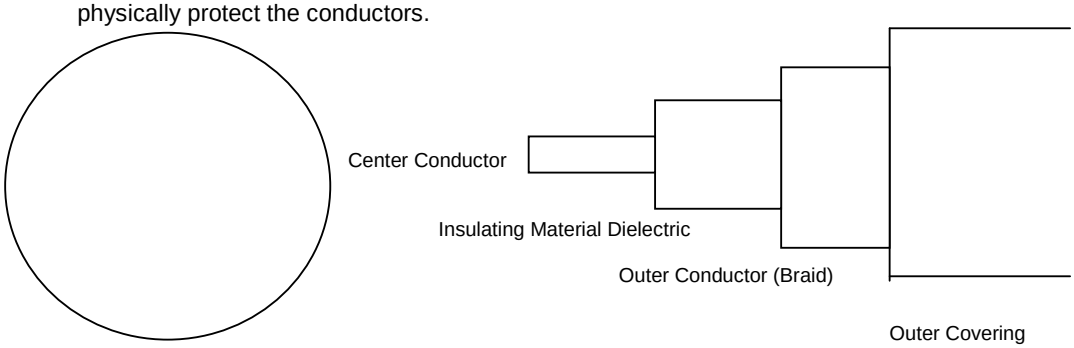
Grounding is the process of electrically establishing a low impedance path between two or more points in a system. An ideal ground plane is zero potential, zero impedance body that can be used for a reference for all signals in the system.

Shielding is the process of confirming radiated energy to the bounds of specific volume or preventing radiated energy from reaching a specific volume. Coaxial cables are one of the mediums used for such application.

Coax Cable:

The most common means of conducting video signals from one piece of equipment to another is through co-axial cable. Co-axial cable has a center conductor surrounded by die-electric insulating material, which in turn is protected by a shield or braid to prevent against electromagnetic interference (EMI). The outer covering of the coax is referred to as the jacket.

A non-conductive or die-electric material separates the coaxial cables into two conductors. The outer conductor acts as a shield and helps isolate the inner conductor from spurious electromagnetic interference. The outer covering helps physically protect the conductors.



The center conductor is the primary means of carrying a video signal. The center conductor generally solid copper is available in varying diameter. Cable with large diameter center conductor have lower resistance than cable with smaller diameters and enhances the ability of a cable to carry a video signal over a longer distance with better clarity.

The dielectric / insulating material is either polyurethane or polyethylene. The dielectric insulator helps determine the operating characteristics of coaxial cable by maintaining uniforms spacing between the center conductor and its outer elements over the entire length of the cable.

Wrapped around the outside of the dielectric materials is a woven copper braid or shield which prevents unwanted external signals commonly called electromagnetic interference of EMI which may adversely affect a video signal. The amount of copper or wire strands in the braid helps determine how much EMI it shields. Use of maximum shield or heavy braid type cable reduces EMI effect.

FILTERING :

It is the process of eliminating conducted interference by controlling the spectral content of the conducted path.

An Electrical fitter is a combination of lumped d or distributed circuit elements arranged, so that it has a frequency characteristic that passes some frequencies and blocks others.

Filters provide an effective means for the reduction and impression of electromagnetic interference as they control the spectral content of signal path.

The type of fitters is classified according to the bounds of frequencies to be transmitted or attenuated.

ELECTROMAGNETIC COMPACTABILITY:

The capability of equipment or system to be operated in their intended operational environment at designed level, of efficiency without causing or receiving degradation owing to unintentional electromagnetic interference. Electromagnetic compatibility is the result of an engineering planning process applied during the life cycle of the equipment. The process involves careful considerations of frequency allocation, design, procurement, production, site selection, installation, operation and maintenance.

European Directive regarding Electromagnetic compatibility gives a general definition of the essential protection requirements, applicable to every electrical and electronic equipment. European Union “Global Approach” requires that every product put in the European market has the ‘CE’ marking fixed on it. The ‘CE’ marking must be fixed by the manufacturer or his agent established within the EU and symbolizes that the affixture explicitly declares and takes entire responsibility of the conformity of the product to all European directives applicable to such product.

The CE marking must be affixed so as to be visible, legible and permanent. The European Electromagnetic compatibility directive applied to all electrical and electronic appliances, installation and systems. The Directive are grouped as

a) Basic standards.
b) Generic Standards.
c) Product Standards.

It defines two essential protection requirements.

1) **Emission requirements:** Every piece of equipment must be constructed so as to ensure that any electromagneticdisturbance it generates allows radio and telecommunication equipment and other apparatus to operate as Intended.

2) **Immunity requirements:** Every piece of equipment must be constructed with an inherent level of immunity to externally generated electromagnetic disturbances.

The Directive establishes that products complying with EU harmonized standards are in conformity with the above essential protection requirements.

Reference: -

1. *Electrical Engineering Hand book. -Richard C. Dorf.*
2. *IEEE – Industry Applications Magazine*