

A Literature Survey On Electromagnetic Interference

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Abstract

Electrical and electronic devices are prone to electromagnetic noise or interference. It has been observed regularly since long that the electromagnetic transmitters are the culprits electromagnetic equipments and living bodies. To protect the victims electromagnetic shields are essential. here we study about the effects of electromagnetic fields.

Electromagnetic interference

EMI (electromagnetic interference) is the disruption of operation of an electronic device when it is in the vicinity of an electromagnetic field (EM field) in the radio frequency (RF) spectrum that is caused by another electronic device. It is a disturbance that affects an electrical circuit due to either electromagnetic induction or electromagnetic radiation emitted from an external source. The disturbance may interrupt, obstruct, or otherwise degrade or limit the effective performance of the circuit.

EMI is unwanted effects in the electrical system due to electromagnetic radiation and electromagnetic conduction. Electromagnetic radiation and electromagnetic conduction are differentiated by the way an EM field propagates. Conducted EMI is caused by the physical contact of the conductors as opposed to radiated EMI which is caused by induction (without physical contact of the conductors). Electromagnetic disturbances in the EM field of a conductor will no longer be confined to the surface of the conductor and will radiate away from it. This persists in all conductors and mutual inductance between two radiated electromagnetic fields will result in EMI.

The increasing demand and dependence on the use of electromagnetic transmission systems for information technology applications has enabled revolutionary communication capabilities to include cordless communication devices, wireless networking and satellite communication systems. As the number of these devices increases, there is an increase in electromagnetic radiation within the segments of the electromagnetic spectrum in which these operate. These emissions have the potential to interfere with the normal operation and function of electronic communication links and systems.

The fundamental concept of electrical and electromagnetic interference involves

an emanating source and an affected device or system. The transfer of energy between systems can occur through radiation, conduction, or induction. The actual transfer of energy is facilitated respectively through a transmission path, conductive path, or through magnetic coupling.

The interference that affects wireless communication links is typically the result

of radiated or conductive energy transfer. The condition of a conductive affect occurs when the signal is picked-up by a conductor attached to the affected system.

The sources of EMI can be generally separated into the following categories:

- Incidental interference
- External noise
- Spurious Emissions
- Adjacent Channel Interference
- Band Congestion
- Environmental Interference
- Intentional Interference (Jamming)

EMI ILI Effects

Biological Hazards

Acute Lymphoblastic leukemia In children , severe burns, affects nervous system

Electrical Hazards

Can overload & destroy electrical equipments

Fire Hazards

Can cause electric currents strong enough to spark when an induced voltage exceeds the breakdown voltage of the surrounding medium.

Biological Effects of Non-ionizing Electromagnetic Fields

The heart and central nervous system i.e. brain of any human body produces electrical activities. The cells of a human body generate number of voltages. Almost those following are most important:

Voltages generated by heart (electrocardiogram-ECG)

Voltages generated by brain (electroencephalogram-EEG)

Voltage generated by muscle tissue (electromyogram-EMG)

Sources & Intensity of Impact of Em Radiation

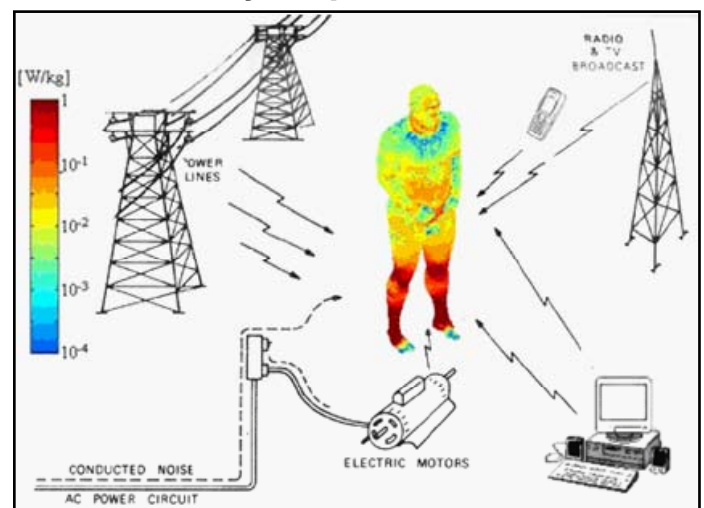


Fig: 1.1

1. In 1992, a patient attached to a monitor-defibrillator in an ambulance died because of interference from the ambulance radio prevented the machine from working (1).
2. In 1987, patient monitoring systems failed to sound alarms because of interference; two patients died as a result (2).
3. In 1993, a patient fitted with a pacemaker went into ventricular fibrillation shortly after being scanned with a metal detector outside a courtroom (2).

EMI Effects on Medical on Instruments

When the patient cable connecting the ECG machines and the patients is hanging up and moving, an EMF may be generated. This EMF may cause error in ECG waves.

4. If during taking ECG the patients touch the iron rails of the cot, then a discharge of charge developed in his body may occur. This may cause generation of spike(s) in the ECG trace.
5. When high power electrical machines are nearby then those may radiate EMI which may be picked up the ECG machine. If the return path of the under wall (hidden) wiring is somehow connected to the steel rods of the building structure, sneak currents may flow. The radiation due to this sneak current and the former cause error in the ECG lines.
6. When ac from power lines or electrical equipments is being picked up by the ECG cables the base line of the trace becomes wider.

Effects on EEG Waves

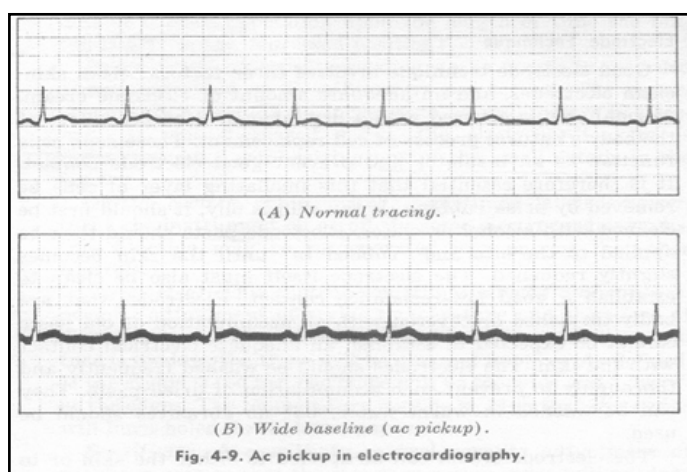


Fig: 1.2

EMI Effects on Machines

Power electronic converters are widely used in many applications including renewable energy generation, industrial equipment/motor drives, electric vehicle/train, air-craft, household appliances, electronic ballasts, computer power supplies, power supplies for telecommunication equipment, etc. These power converters use the fast switching power semiconductor switches, such as MOSFET (Metal-oxide semiconductor field effect transistor), IGBT (Insulated Gate Bipolar Transistor) as the preferred switching devices as they have many properties, such as higher efficiency, smaller size, and lower overall cost, low losses associated with switching device. However, fast switching speed of new converter/inverter technologies has the potential to cause EMI and high dv/dt.

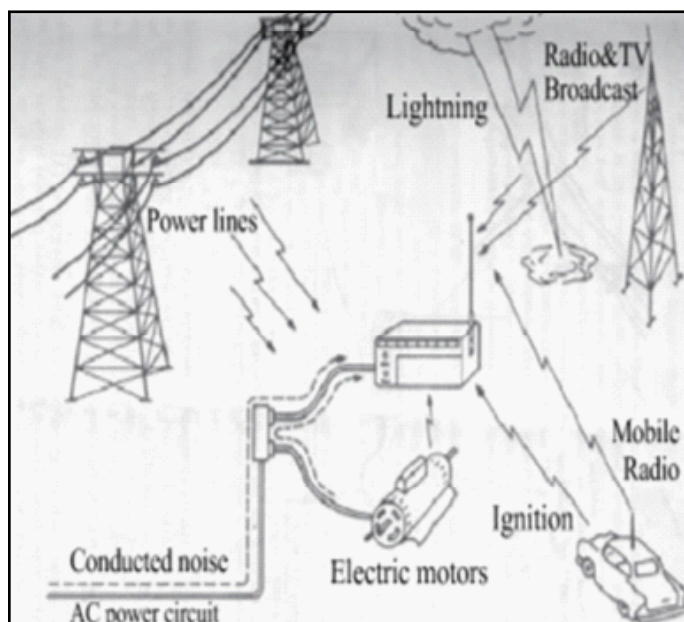


Fig: 1.3

All power electronics equipments generate and emit unwanted electrical signals (EMI noise) that can lead to performance degradation of other electrical/electronic equipments. They generate high-frequency conducted and radiated EMI noise and draw distorted line currents due to the sharp edges of the switching waveforms with high dv/dt. The undesirable EMI effects are interference with wireless systems (e.g., radio, TV, mobile, data transmission), malfunction of biomedical equipments (e.g., cardiac pace maker), misbehaviour of security doors of banks, ABS brake systems of cars, and electronic control systems in airplanes and the increase in power system losses associated with improper performance or failure of a range of industrial power equipments.

Fundamentals of Electro Magnetic Compatibility

In the past the majority of appliances used in the electrical installations of conventional buildings were linear loads (such as ac-dc-motors, resistive loads, filament lamps etc.), which lead to no, or very little, interference between different items of equipment. These produce narrow band noise (due to devices switching at fixed frequencies above 9 kHz) which can spread all over the network. Typically Switch-Mode Power Supplies produce this type of conducted interference signal (operating in the range of 10 kHz to 100 kHz)..

On one hand, power supply systems are becoming more powerful, which can lead to electromagnetic interference (EMI); on the other hand digital networks are expanding, becoming more sensitive, performing at higher data transfer rates and are increasingly used for safety related tasks. This development demands high quality electrical installations in all buildings where electromagnetic non-compatibility leads to either higher costs or to an unacceptable decrease in safety standards.

Basically all electrical conductive components of buildings and facilities play a role in electromagnetic interference either as a source (EMI transmitter) or as a drain (EMI receiver).. It often appears that any installation may act as a source and a drain simultaneously. Typical systems are:

- Power supply lines
- Measurement and control devices
- Alarm devices

Computer installations, including networks.

Fields As The Fundamental Source of Electromagnetic Interference

Electromagnetic compatibility (EMC) describes the ability of any electrical or electronic system, machine, appliance etc. to operate without malfunction in a disturbing electromagnetic environment while not itself disturbing the operation of other components of the system.

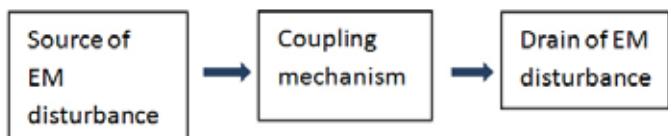
The fundamental sources of any electromagnetic interference (EMI) are the basic fields and currents of electrodynamics. At low frequencies the electric and magnetic fields act independently; at high frequencies only the propagating electromagnetic field is of importance.

All fields at low, medium and high frequency are generated by electric charges and currents. At low frequencies the electric and the magnetic fields are relatively short-ranged, falling off in intensity from their source at least inversely proportional with distance, and are therefore concentrated in the vicinity of the lines of the conductor that might carry some current or voltage.

Since the electric field is proportional to the voltage of the electrical installation, it will only be of sufficient strength to cause EMI effects at large distances in the vicinity of high voltage installations.

Types of Electromagnetic Couplings

To describe the mechanism of electromagnetic interference it is easiest to start with a very simple model. It consists of a source, which causes the interference, a coupling mechanism or coupling media and the disturbed device.



Elementary coupling model of EMI shown before.

Examples of sources may, as mentioned above, be lines of the electrical power system, antennas of wireless LAN systems, etc. The coupling is established via the current if common conductors by different circuits are shared by the electric, magnetic or electromagnetic fields. The disturbed drains may be any kind of apparatus or any parts of the electrical installation.

Four different types of elementary EMI can be identified:

- Impedance coupling
- Inductive coupling
- Capacitive coupling
- Radiative coupling.

The basic physical properties of the different coupling methods are summarized in the following table:

Source	Frequency Domain	Coupling	Range	Drains
Electric field	Low frequency	Capacitive	Short	High and low voltage cables
Magnetic field	Low frequency	Inductive	Short	High and low voltage cables

Electromagnetic field	High frequency	Radiative	Long	High and low voltage cables
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Radiation Coupling

Electromagnetic fields travel through space with the velocity of light $c = 2.998 \times 10^8$ m/s and may influence electrical installations in the near or far surroundings of the source. Typical sources of electromagnetic fields are radio or TV transmitters, mobile telephones or any other kind of wireless applications. The high frequency parts of fast signals or of fast transients (ESD, surge, burst lightning) may also lead to the radiation of electromagnetic fields by cables or any other conductive parts of the electrical installation and may cause disturbances in electrical systems in other parts of the building. If the disturbances on the power supply or data network contain high frequency components, other elements of the installation may act as antennas and radiate the electromagnetic fields. The Hertz Dipole may serve as an elementary model to estimate the magnitude of radiated fields. All conductive parts of the electrical installation may serve as antennas, including Cables Openings and slots of cases, cubicles etc. Printed board strips.

Openings and slots of equipment cases radiate disturbances into the surrounding area or into the housing, so disturbing other objects in the environment and/or transmitting electromagnetic fields from the outside into the systems. In practice, housings cannot be completely closed. Openings such as entry ports for cables and ventilation slots and gaps around doors are unavoidable. These openings reduce the effective shielding of any housing. By intelligent construction of the housing, an acceptable level of shielding may be obtained. The amount of leakage from a discontinuity in the shield depends mainly on three factors :the maximum linear dimension of the opening
the wave impedance
the frequency of the source.

The primary usages of copper in wire cloth are in those applications requiring corrosion resistance, electrical and thermal conductivity, spark resistance and non-magnetic properties. Copper wire cloth finds wide usage in traveling water screens, radio frequency interference shielding, sugar and marine applications. Copper applications are limited due to its low tensile strength, poor resistance to abrasion and common acids.

References

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