Electronic System Design and Manufacturing

Even Sem 2019

Course Outcomes

1) Explain EMC regulations for military and commercial standards.
2) Design shielding circuits to prevent capacitive and inductive coupling.
3) Design filtering circuits for electronic systems.
4) Explain EMC compliance of capacitor and conductor.
5) Calculate S/N ratio and noise factor for various electronic circuits.
6) Explain ESD protection in equipment design.
7) Explain procedure for PCB layout and stackup

EMC?

- ElectroMagnetic Compatibility
- Why?
  - Electronic ckts used in communication, computation, automation etc.
  - Different ckts work in close proximity to each other
  - May affect each other adversely
    - EMI is a major problem!
  - More and more ckt's are being crowded in smaller spaces
    - 2.6 Billion transistors in Core i7 of 2014 (29,000 for 8086!)
    - Increases probability of interference
  - Clock frequencies now a days are in GHz range.

EMC compliance

- Required for devices designed to work in real world-> comply with Govt. EMC regulations
- Equipment should not be affected by external EM sources
- Also it should not be a source of EM noise

Noise and Interference

- Noise
  - Any electrical signal present in a ckt other than the desired signal
  - Def. Excludes distortion products produced “in” ckt due to non linearities
  - Not considered noise unless coupled to other part of ckt. (although undesirable)
  - A desirable signal in one part can be undesired in other part

Categories of Noise

- Intrinsic
  - Random fluctuations within physical systems
    - Thermal noise, shot noise
- Man made
  - From motors, switches, RF etc.
- Natural sources
  - From lightning and sun spots etc.

Designing for EMC

- EMC
  - It is the ability of an electronic system to
    A) Function properly in its intended electromagnetic environment
    B) Not to be a source of pollution to that EM environment
- EM environment is composed of both **radiated** and **conducted** energy
- Thus EMC has two aspects
  1. Emission
  2. Susceptibility

Susceptibility

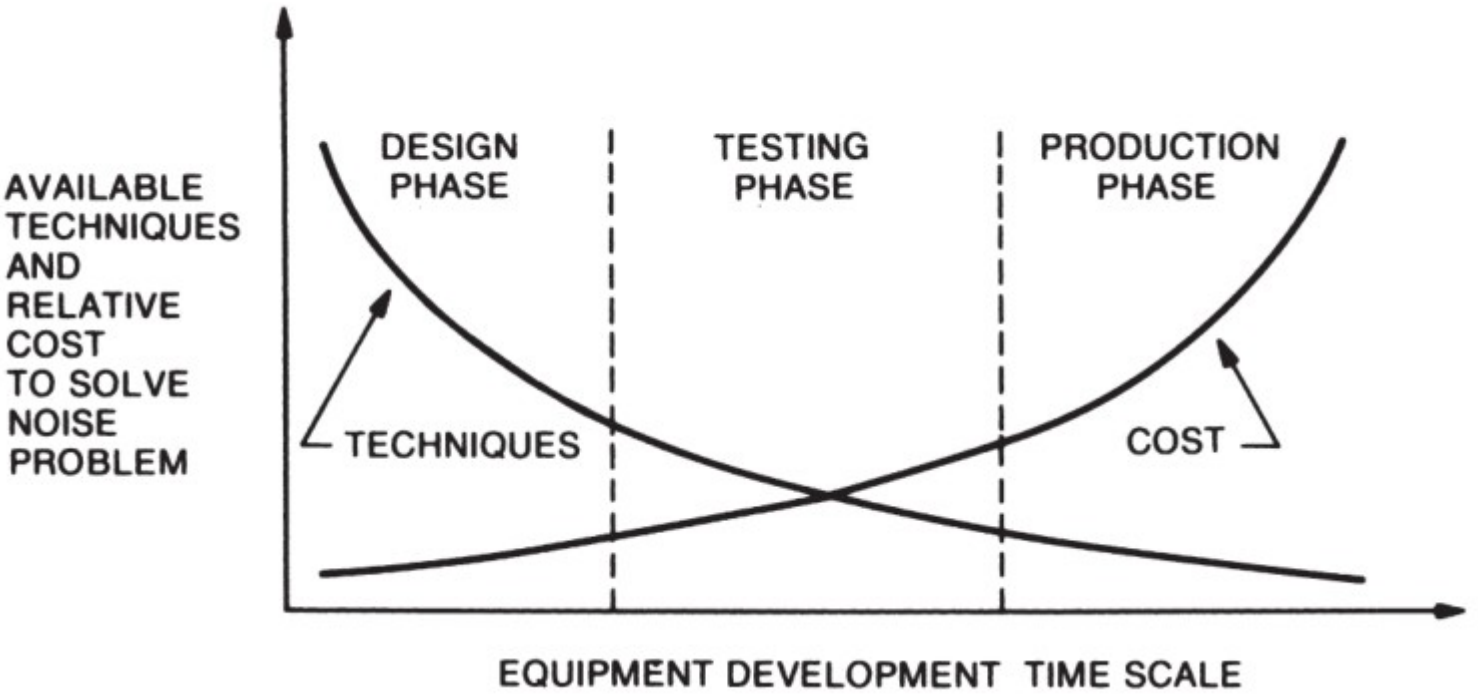
- Capability of a device or ckt to respond to unwanted EM energy
- Opposite of susceptibility is immunity
- Immunity level
  - Upto which the device or ckt ca work without degradation or with defined margin or safety
  - How to define what constitutes performance degradation?
- Susceptibility can be self regulating
  - If a device is being affected by radiation, one may stop buying the product

Emission

- It is the interference causing potential of the product
- Controlling emission from one product may eliminate an interference problem for many other products
- Emission is not self regulating
  - Its own emission may not affect itself

EMC Engineering

- Design of all electronic products requires to meet EMI/EMC regulations across the world
- Two approaches to EMC engineering
  1. Crisis approach
     - Design first, fix later
     - Expensive add-ons
     - Band aid approach
  2. Systems approach
     - EMC considered throughout the design process
     - EMC problems addressed at prototype stage with testing
     - Cost effective and desirable
     - Mitigation techniques are simple at single stage or subsystem


AVAILABLE TECHNIQUES AND RELATIVE COST TO SOLVE NOISE PROBLEM
DESIGN PHASE
TESTING PHASE
PRODUCTION PHASE
TECHNIQUES
COST
EQUIPMENT DEVELOPMENT TIME SCALE

- Problems with crisis approach
  - Difficult to find culprit in finished product
  - Solutions require additional components
  - Added engineering and testing cost
  - Added component cost, wasted time
  - Size, weight, power penalties

Engineering Documentation shortcomings

- EMC information is not included
- e.g.
  - No information as to where and how ground should be connected
  - Parasitics not shown
  - Components with ideal characteristics depicted