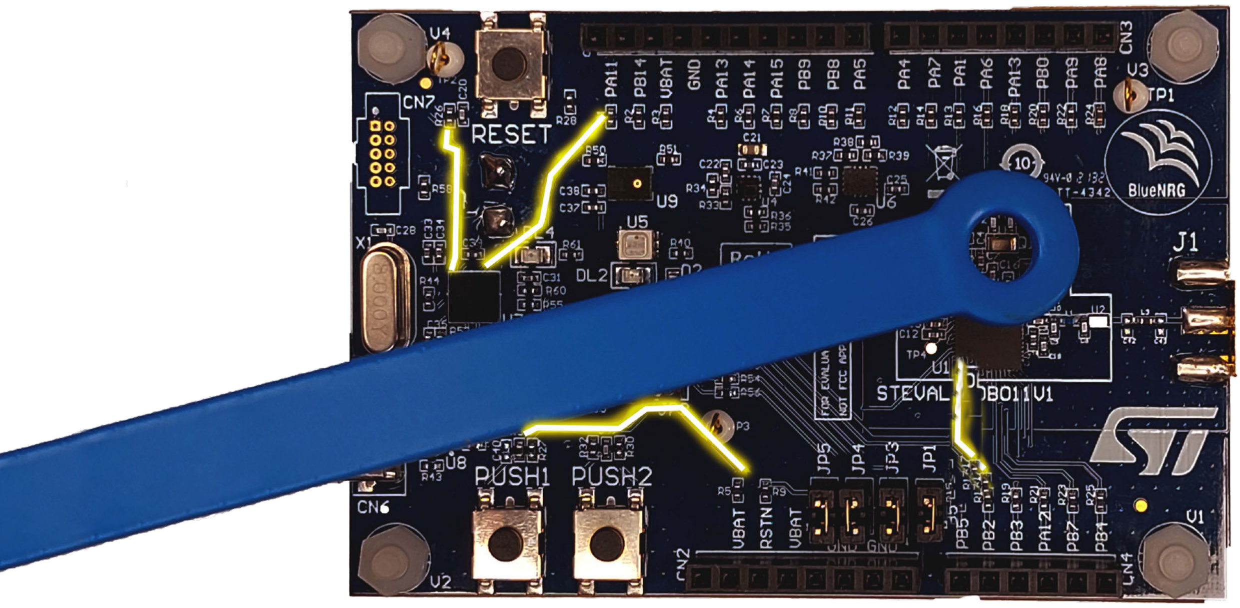
INTERLLIGENT
RF & Microwave Solutions



EMC For Electronic Circuit Designers

4-day (32 study hours) course

RF Training

Test Equipment

Engineering Services

RF Ventures Incubator

RF is our Business... Signal us!

Introduction

Electromagnetic compatibility, or EMC, deals with various disciplines. From DC such as lightning protection, power electronics, high-speed signals to RF sensors. From small-scale systems (ioT) to large platforms (avionics, automotive). The objective of EMC is to design the system to work as expected, without effects on/from the surroundings, and to comply with EMI control standards, commercial or military.

The design cycle ends when the electronic system:

1. Operates as it was designed to, without any performance degradation.

2. Passes the EMC tests.

Failure in one of the above may lead to excessive costs in troubleshooting and sometimes in additional layout cycles. It is therefore advised to invest in EMC design from the early stages of the project, until the project ends.

Current technology developments lead to much more complex systems in small form factors, and higher data rates.

In this course, the audience will familiarize with EMC basics and advanced know how, related to board design, through a methodological presentation backed by practical examples.

The goal of the course is to **"Upgrade the engineer's abilities to design electronic systems with regards to EMC."**

Who Should Attend

Electrical and Electronics Engineers who work in the development of electronic systems:

- Board designers
- Integration engineers
- System engineers
- Qualification/testing engineers
- EMC engineers

The Presenter - Avi Cohen

- **Lecturer** at Ort Braude Electrical Engineering Department
- **EMC Consultant**
  - Multidisciplinary Project
  - EMC 3D Simulation
  - Electromagnetic radiation safety [humans, explosives]
- **IEEE EMC & Signal, Power Integrity ISRAEL** chapter chair
- **EMC focal point for the Government Of ISRAEL** 2001-2021
- **B.Sc., M.Sc. in electrical engineering**

Syllabus **subject to changes**

Basics

Subject 1 | EMC Fundamentals | 3 Hours

- What is electromagnetic compatibility (EMC)
- Basic Mechanisms of electromagnetic interference
- Inter/Intra system EMC)
- Mandatory test electric board must pass [military, commercial]
- Platform interference Vs. Mandatory test
- Electromagnetic Interference (EMI), Radio Frequency Interference (RFI)
- Electromagnetic coupling mechanisms

Subject 2 | Frequency content of digital signals | 1 hour

- Digital signals as a trigger to EMI
- Narrowband Vs. broadband signals
- Spectral content of digital signals
- Signal Bandwidth - EMC Vs. Digital Processing

Subject 3 | Transmission Lines | 2 hours

- Background
- EMI due to reflections in transmission lines
- Damping techniques

Subject 4 | Common-mode Vs. Differential Signals | 1 hour

- The nature of signal sources
- Examples- RS232, RS-422, LVDS, Ethernet
- Unbalanced circuits as a source of common mode EMI

Subject 5 | Radiated emissions | 2 hours

- Electric and magnetic dipoles
- Main radiators in an electric board (traces, reactive components)
- When to consider trace and cables as effective radiators
- Common-mode and differential radiation
- Clock sources: types and layout

Subject 6 | Radiated Susceptibility | 1 hour

- Susceptibility simplified models
- Estimation of induced voltage on sensitive components nets

Subject 7 | Passive filtering for EMI control | 5 hours

Conductors

- Conductors - are conductors really transparent?
- Short/long conductors
- Skin effect and resistance
- Parasitic inductance in conductors: the cause of switching noise

Capacitors

- Ideal vs. realistic capacitors
- Types and applications of capacitors
- Decoupling capacitors
- X,Y capacitors
- Leakage-current limitation

Inductors

- Ideal vs. realistic inductors
- Types of inductors (common mode choke, differential inductor)
- Shielded inductors
- How to mitigate EMI with a soldered inductor

Ferrites

- How ferrite beads work
- How and when to use ferrite beads
- Is a ferrite sufficient to mitigate EMI?

Filtering

- Types of filters - L,T,π
- Optimal placementof filters
- Filter references ground design references
- EMI filter design: passive low-pass for signals
- EMI filter design: passive low-pass for power delivery network
- Medical regulation filters EN60601
- Examples

Subject 8 | Grounding | 2 hours

- Types of grounds - digital, analog,single and multiple grounding
- Current return paths
- How to manage grounding in PCBs
- Chassis ground connections
- When to split grounds, and when not to
- Grounding scheme
- Tips and rules of thumb for grounding
- Ground pins in connectors

Subject 9 | Cabling | 2 hours

- Magnetic coupling
- Electric coupling
- Shielded cables - basics, characteristics
- How to implement cable bonding
- Pigtail and its effect on EMI

Subject 10 | Transient signal suppression | 2 hours

- ESD basics
- When do we need to protect electronic components
- Types of transient suppressors
- How to implement ESD circuit protection (components, ESD ground)

Subject 11 | Enclosures | 1 hour

- Shielding basics
- Types of shielding materials
- Wave impedance of EMI
- Absorbers Vs. Conductive material
- EMI shielding - good practice guide

Advanced Topics

Subject 12 | Circuit design | 5 hours

- EMI in circuits
- The EMC process
- Component placement in PCBs
- PCB stackup - key principles for reducing EMI
- Board-level filtering
- Do copper pours reduce EMI?
- IC - EMI signature introduction
- Signal integrity issues
- Heatsinks and their contribution to EMI
- Layout Layout Layout!!! - Do and Don't Do

Subject 13 | Power delivery networks | 5 hours

- Basic design of power delivery networks
- Noise rejection of PCB components
- Switching noise, and how to filter it
- When to isolate the power planes (?)
- LDO oscillations
- Buck converters as one of the main sources of EMI
    - Basic operation
    - Types and trends of buck converters
    - Body diode as major source of EMI
    - Operating frequency of a DC-DC converter vs. receiver sensitivity
    - Layout of buck converters:- Design guide
    - Methods for mitigating EMI from buck converters
- Spreading the EMI noise sourced by switching frequency

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