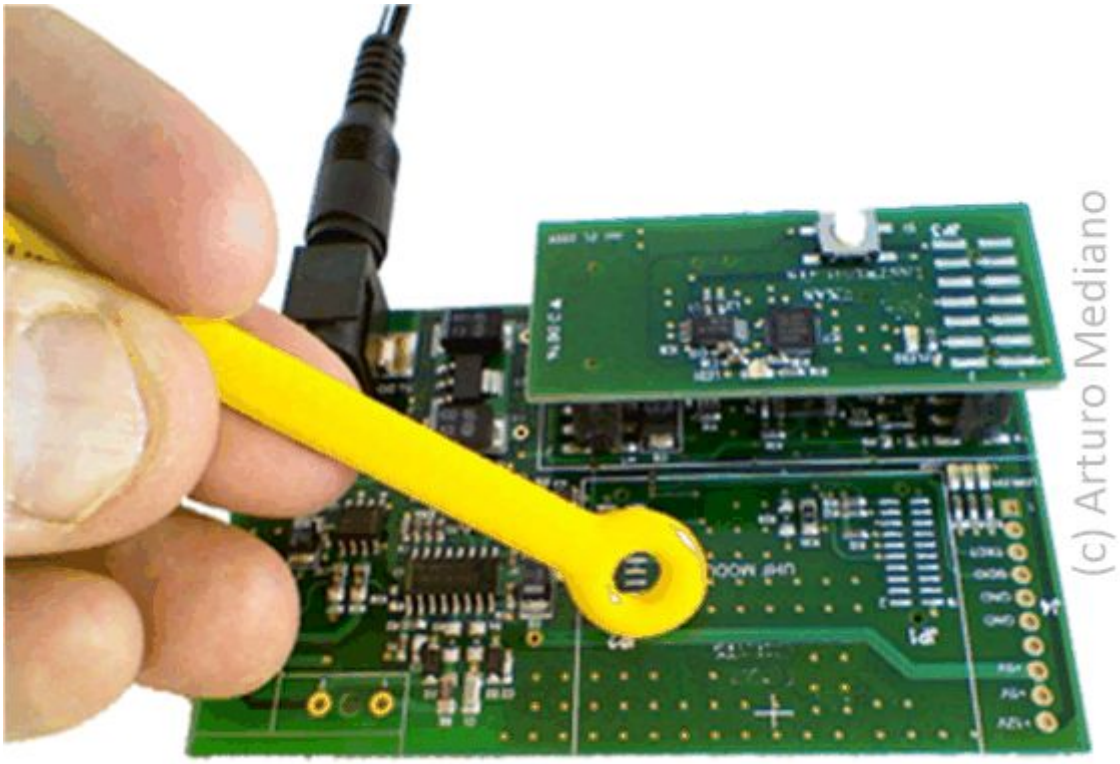
Design without EMI. Design for EMC.

21–23 Jan 2019, Prof. Arturo Mediano, Uni. Zaragoza, Analog Devices, Limerick

Course fee: members €300; Non-members €450

Learn the secrets and techniques in EMI/EMC design and troubleshooting, covering basic techniques and fundamentals.



Learning outcomes:

Learn key **EMI/EMC principles and fundamentals** through key ideas, real examples and tricks for engineers and technicians in design, installation, and production of electronic devices and circuits.

Understand general ideas to design an electronic product avoiding electromagnetic interference (EMI). Study electromagnetic compatibility (EMC) problems and learn useful ideas for EMI/EMC troubleshooting (diagnosis and resolution).

1. - INTRODUCTION TO EMI/EMC DESIGN

Why EMI affects electronic systems, examples. EMI/EMC classification (1): radiated vs. conducted. EMI/EMC classification (2): emissions vs. immunity. Source, victim and coupling mechanisms. Electrical signals. Maxwell vs. Kirchhoff: limits of circuit theory. Spectrum of a signal: time domain vs. frequency domain. Decibel and logarithmic scales. Resonance. Quality factor (Q) both loaded and unloaded. Frequency versus dimensions (size). Time vs. distance. Skin effect, return current and parasitic effects. The importance of rise time and fall times (dv/dt and di/dt). Key factors for EMI. Controlling signal return currents. Differential vs. common mode currents. EMI coupling mechanisms. Non ideal components (when a capacitor is an inductor). The "hidden schematic" concept. Antenna basics: dipoles and loops. Antenna resonance. Near vs. far field. Low and high impedance signals and circuits. "Hidden antennas": radiation and pickup.

2. - GROUND AND EARTH IN ELECTRONIC SYSTEMS

Signal ground vs. safety ground. Ground in high frequency/speed applications: low impedance path. How to minimize ground impedance. Common impedance. Ground strategies (single point, multipoint, and hybrid). Ground loops.

3.- FILTERING TECHNIQUES

Filters for EMI/EMC. How filters work: reflection vs. dissipation. Insertion losses. Source and load influence. Parasitic and location effects. Filtering with capacitors and inductors. Filtering with ferrites and resistors. Saturation and undesired coupling effects. Decoupling and bypass fundamentals. Damping resonances and ringing. Three terminal and feed through components. Mains filters (differential mode and common mode), filter mounting and layout.

4.- PCB DESIGN AND LAYOUT

Typical problems in PCBs. Design strategy. Partitioning and critical zones. Choosing the PCB structure: how many layers and distribution. Power planes design and distribution. Layout and routing (1, 2 and multilayer) techniques: traces, microstrip and stripline, corners, vias, signal integrity basics, transmission line effects and solutions. Ground planes. Splits or ground discontinuities in planes (slots). Decoupling and bypass (how, where, resonances, etc.): discrete capacitors vs. embedded techniques. Crosstalk.

5.- CABLES AND CONNECTORS IN EMI/EMC

Cable fundamentals. Cables as antennas for emissions and pickups. Types of cables (wires, twisted pairs, coax, shielded cables, ribbon cables, etc.). Shielded cables and cable grounding. Avoiding crosstalk and reflections in cables (layout and

terminations). Avoiding common impedance in cables. Reducing emissions and pick-up in cables.

6.- SHIELDING

Basic ideas, how shields work: reflection vs. absorption. Influence of material, shielding effectiveness. Low vs. high frequency fields, electric vs. magnetic fields. How to destroy a shield: holes and slots, shield penetrations, holes for fans and displays. Gaskets. Evaluation of shields.

7.- DIAGNOSTIC AND TROUBLESHOOTING. EXPERIMENTS

Strategy. Useful tools and instruments: voltage probes, current probes, near field probes. Measuring voltage: scope and probe limitations. Measuring current: probe response and transfer impedance. Measuring electric and magnetic fields. Diagnostic and troubleshooting techniques and hints. Locating EMI sources/victims with near field probes. Examples. Practical demonstrations.

Prof. Arturo Mediano profile

Prof. Arturo Mediano is the founder of "**The HF Magic Lab**®", a specialized laboratory for design, troubleshooting and training in EMIC/EMC, RF and Signal Integrity subjects. It is part of the **Aragon Institute for Engineering Research** of the **University of Zaragoza**, Spain. He has contributed to more than 90 papers presented at symposia and conferences related to EMI/EMC/RF and 150 scientific publications. He has taught many EMI/EMC/SI/RF courses for more than 100 industries, institutions and at conferences.