

**EMC & Compliance International, 2020**  
**Overview of the Training Workshop Programme,**  
at 15 February 2020

Presented by Keith Armstrong of Cherry Clough Consultants Ltd  
in plain English from one engineer to another,  
*without any maths (well, hardly any!)*



**Wednesday May 20<sup>th</sup>**

Wednesday 08:30 - 09:00 Registration & Refreshments

**Wednesday 09:00 – 10:30 The Physics of SI, PI and EMC**

Everything we need to understand for well-proven, right-first-time, cost-effective design for Signal Integrity (SI), Power Integrity (PI) and Electromagnetic Compatibility (EMC), up to at least 24 GHz.

- Electromagnetic fields, waves, & importance of the return current path
- Field theory, permittivity, permeability, wave impedance and velocity
- Near-field and Far-field
- Three types of EMC analysis (includes Skin Effect)
- Waveforms, spectra, and ‘accidental antennas’
- Three parts to every EMC issue, and four types of EM coupling
- Differential mode and common mode
- The EMC benefits of metal planes
- Overview of RF emissions
- Safety earthing/grounding does not help EMC at RF
- Non-linearity, demodulation and intermodulation
- Three interference mechanisms
- Overview of RF immunity
- “Internal EMC” and crosstalk
- Improving profitability while reducing financial risks
- Introduction to EM Engineering
- Controlling return currents with metal planes
- EM Zoning using guidelines based on the wavelength,  $\lambda$ , at  $f_{MAX}$
- Some useful references and equations

Wednesday 10:30 - 11:00 Refreshments in the Exhibition Hall  
and Exhibition Visit

**Wednesday 11:00 – 12:30 Circuit design for SI, PI and EMC**

- Digital circuits
- Rise/fall times and emissions spectra

- Numerous digital circuit design techniques
- Watchdogs and brownout monitors
- Data scrambling and spread-spectrum clocking
- Firmware/software
- Analogue (baseband) circuits
  - Linearity, bandwidth and stability of feedback circuits
  - Numerous analogue circuit design techniques
  - Using hysteresis in comparators
- Switching power converters
  - “EMC benign” and spread-spectrum techniques
  - Reducing  $dV/dt$  and  $dI/dt$  with snubbers
  - Heatsinks
  - Use SiC Schottky or soft-switching rectifiers, SiC or GaN switching devices
  - The isolating transformer’s interwinding capacitance
- Communications circuits
  - Better alternatives to copper cabling
  - How to use copper cabling
  - Common-mode noise reduction techniques
  - Optoisolators and optocouplers
  - Gigabit laser diodes
  - Terminating transmission lines

Some useful references

**Wednesday 12:30 - 14:00** Lunch in the Workshop area.  
Refreshments also in Exhibition Hall

**Wednesday 14:00 - 15:30 Shielding for SI, PI and EMC**

- Shielding with metal plates (image planes)
- How shielded enclosures work
- The problems caused by apertures
- The problems caused by box resonances
- The problems caused by conductor penetrations
- Shields in the near field of a source
- RF-bonding with multiple metal bonds or conductive gaskets
- Waveguides-below-cutoff
- Shielding of displays
- Shielding of ventilation
- Shielding of plastic enclosures
- Preventing corrosion at shielding joints
- Some free SE calculators and useful references

**Don’t forget the evening presentation by the IEEE EMC Society’s Distinguished Lecturer, on “the EMC and EMF of Wireless Power Transfer”, with pre-event snacks and drinks provided by the IET’s Electromagnetics Professional Network.**

**Open to everyone, whether an IEEE or IET member or EMC + Compliance International visitor – or not!  
Held 18:30 – 19:30 in the Workshops area, 1<sup>st</sup> floor of the Grandstand, snacks from 17:00.**

## Thursday May 21<sup>st</sup>

- Thursday 08:30 – 09:00      Registration and refreshments
- Thursday 09:00 – 10:30      Filtering for cost-effective SI, PI and EMC**
- How filters work
  - The advantages of soft ferrites
  - CM filtering
  - Specifying filters
  - Real-life problems with resonances, inductors, and capacitors
  - Earth leakage currents and safety
  - Filter construction, mounting, and cabling
  - The synergy of filtering and shielding
  - Some useful references
- Thursday 10:30 – 11:00      Refreshments in the Exhibition Hall  
and Exhibition Visit
- Thursday 11:00 – 12:30      Essential PCB design and layout  
for cost-effective SI, PI and EMC**  
*– a full day's course in just 90 minutes!*
- EM Zoning (i.e. segregation)
  - Interface analysis, filtering, suppression and board-level shielding (BLS)
  - 0V(GND) and power (PWR) planes
  - PCB-chassis RF-bonding
  - Power supply decoupling
  - Matched transmission line techniques
  - Layer stacking and trace routing
  - Devices with BGA packages and/or multiple DC rails
  - Some useful references, sources, and webinars
- Thursday 12:30 – 14:00      Lunch in the Workshop area.  
Refreshments also in Exhibition Hall
- Thursday 14:00 – 15:30      Advanced PCB design & layout for cost-  
effective SI, PI & EMC, up to 10s of GHz**  
*– a full day's course in just 90 minutes!*
- Future trends and their implications
  - Guidelines, approximations, simulations, and virtual design for SI, PI and EMC
  - Advanced segregation (zoning) techniques

Advanced interface filtering & suppression, including BLS, up to tens of GHz  
Advanced PCB-chassis bonding  
Advanced PCB planes, and co-locating radio/TV/wireless datacom antennas  
The totally shielded board assembly  
Damping the resonances in parallel planes,  
    plus Virtual Ground Fences, Electromagnetic Band Gaps, High Impedance Surfaces  
Advanced PCB decoupling  
Buried components, especially buried capacitance decoupling  
Advanced transmission lines, including differential signalling up to 32Gb/s  
Microvia (HDI) board manufacturing techniques  
3-D Moulded PCBs, and Additive Manufacturing  
Some useful contacts, sources, and references

## **Bio for Keith Armstrong**

Keith graduated from Imperial College, London, UK, in 1972 with an Honours Degree in Electrical Engineering. He has been a member of the IEE/IET since 1977 and a member of the IEEE since 1997. Appointed both IET Fellow and IEEE Senior Member in 2010.

After working as an electronic designer, project manager then design department manager, Keith started Cherry Clough Consultants in 1990 to help companies reduce project costs and timescales, warranty costs and other financial risks, through the use of well-proven signal integrity, power integrity and EMC engineering design and manufacturing techniques. By 2020 he had well-over 800 satisfied customers worldwide.

Keith has published several books and a great many articles, and taught many training courses worldwide. In 2018 he was first person to receive the new IEEE award: *'Excellence in Continuing EMC Engineering Education, for continuing education in EMC, signal integrity, and power integrity from a practically based point of view'*.