



Another EMC resource
from EMC Standards

Four day course for Military and Aerospace electronic
designers

Helping you solve your EMC problems



Practical Electronic Design Techniques for Cost-Effective SI, PI and EMC, 2023 (2 days)

— *plus* —

Basic + Advanced PCB Design and Layout Techniques for SI, PI, EMC in 2023 (2 days)

A Four-day Training Course
for military and aerospace electronic designers

by

Keith Armstrong, of Cherry Clough Consultants Ltd, U.K.

Synopsis

Training for electronic, mechanical and PCB/PWB design engineers, and their managers, in the use of good SI, PI and EMC design and manufacturing practices for modern products and equipment.

This is the same as our 3-day course, with a full day on Advanced PCB design topics added.

More course modules are available to customise this course.

(A 5-day version is available that adds more SI, PI and EMC topics and generally provides everything that electronic designers need to know, including low-frequency power converter issues.)

Objective

The aim of the course is to help companies quickly improve their commercial and financial performance by using design techniques that have been proven in real-life for many years to:

- Bring advanced products to market more quickly
- Reduce unit manufacturing costs
- Reduce warranty costs and costs of ownership by improving reliability
- Easily comply with legal EMC requirements

- Reduce financial risks and improve Return On Investment

This course is highly recommended for those involved in any aspect of the design or testing of electrical/electronic products.

It is based upon the EMC course module that Keith taught to post-graduate students as part of the IET-accredited Sensors and Electronic Instrumentation M.Sc. course at the University of Manchester (formerly UMIST, University of Manchester Institute of Science and Technology), UK.

Who Should Attend

All electronic designers and their managers, in all industry areas, including:

Automotive	Medical & healthcare	
Consumer	Household (domestic) appliances	
Information Technology (IT)	Industrial instrumentation or control	
Railway	Marine	
Aerospace	Military	
Telecommunications	Radiocommunications	Datacommunications

Prerequisites

Familiarity with circuit (hardware) design, PCBs/PWBs and electronic and mechanical assembly and interconnection techniques.

Plain English is used, with a small amount of very easy mathematics.

Course Methodology

This course is presented classroom style using a PowerPoint slideshow containing practical illustrations of the techniques to aid understanding.

Case studies that are relevant to the trainees will be included verbally.

Each attendee will be presented with a bound copy of the PowerPoint slides used during the training, printed at 6 slides per page. The spaces around the slides usually suffice for taking extra notes.

Copies of textbooks (see page 7) can be provided at extra cost.

Course Duration

Four (4) full days, each 9:00am – 5:00pm (for example, other timings may be used).

This is a very intensive course with a very large amount of practical detail.

If presented as an in-house course it can be very usefully combined with individual consultancy for each engineer or manager, to help him or her apply the material to his or her current projects.

In countries where English is not the first language, a longer duration may be preferred.

Venue and Date

To be decided. The course could be provided as a public course, or as an in-house course.

As an in-house course, it has the added value of allowing confidential discussions on how best to apply the material to particular projects or products.

COURSE OUTLINE

DAY 1

What is EMC and how can we deal with it cost-effectively?

What interference can occur, and how it affects hardware and software

EMC approaches for regulatory compliance; high reliability or functional safety

Saving time and money with good EMC techniques

EMC specifications and standards

Cables and connectors

EMC filtering (with an emphasis on military/aerospace equipment)

EMC shielding (with an emphasis on military/aerospace equipment)

DAY 2

Circuit design

Digital, analogue, switching power converters, datacomm's, etc.

Choice of components for EMC, second-sources, counterfeits

Suppressing electrostatic discharge (ESD)

Suppressing surges/transients on military vehicle DC supplies, signals & data

Heatsink design for EMC

DAY 3

PCB design/layout techniques generally required for good SI, PI, and EMC in 2023

- Saving time and money
- Scope and application of these design and layout techniques
- EM Zoning (i.e. circuit segregation)
- Interface analysis, filtering, and suppression
- Planes for 0V(GND) and other power rails (PWR)
- RF-bonding PCB Reference Planes at EM Zone boundaries
- Power supply decoupling
- Switching power converters (inc. AC-DC, DC-DC, DC-AC, AC-AC, etc.)
- Matched transmission line techniques
- Layer stacking and trace routing
- Devices with BGA packages and/or multiple DC power rails
- Some useful references, sources and webinars

DAY 4

Advanced PCB design/layout techniques for good SI, PI and EMC in 2023

- When should we use advanced PCB techniques?
- Future trends and their implications
- Guidelines, approximations, simulations, and virtual design for SI, PI and EMC
- Advanced EM Zoning (segregation) techniques
- Advanced interface filtering and suppression, including using board-level shielding and Metamaterials to 60+ GHz
- Advanced RF-bonding for PCB Reference Planes at EM Zone boundaries
- Advanced PCB planes (and co-locating radio/TV/wireless datacom antennas)
- The totally shielded board assembly
- Damping the resonances in parallel metal structures, including Metamaterial methods e.g. Virtual Ground Fence; EBG (Electromagnetic Band Gap); HIS (High Impedance Surface), Split-Ring Resonators, etc.
- Advanced PCB power supply decoupling
- Buried components (especially buried capacitance decoupling)
- Advanced transmission lines, up to at least 32Gb/s
- Microvia (i.e. high density interconnect, HDI) board techniques
- Future developments, including: a) 3D Moulded PCBs; b) Additive Manufacturing of PCBs; c) Replacing PCBs with 'SIF' (Silicon Interconnect Fabric) that use 'Chiplets'
- Advanced crosstalk
- Some final 'tips' and 'tricks'
- Some useful contacts, sources, references and webinars

A more detailed course contents list is available upon request.

Course Instructor

Academic Qualifications

BSc (Elec.Eng), Upper 2nd Class with Honours, Imperial College of Science & Technology, London, UK, 1972

Professional Qualifications

Fellow IET (Institution of Engineering and Technology, formerly the Institution of Electrical Engineers, IEE), London, UK (Member since 1977) 2010
Senior Member IEEE (Institute of Electrical and Electronic Engineers Inc.) USA, member of its EMC, Product Safety Engineering Societies since 1998 2010
Associate of the City and Guilds Institute, London, UK 1972
UK Chartered Engineer, Engineering Council, London, UK 1978
Group 1 European Engineer (EurIng), FEANI, Paris, France 1988



Professional Activities

Chair of IEE/IET's Working Group on EMC and Functional Safety 1997-date
Chair of IEEE EMC Soc. Special Committee on Risk Management of EMC 2012-2016
UK expert appointed (by invitation) to IEC maintenance team MT23 for IEC 60601-1-2 (Medical Equipment/Systems EMC) 2006-date
UK expert appointed (by invitation) to IEC maintenance team MT15 for IEC 61000-1-2 (EMC & Functional Safety) 2003-date
UK expert appointed to IEC 61000-6-7 (EMC & Functional Safety, Generic) 2010-date
Member EMC Industries Association (EMCIA) 2003-date
Member EMC Test Labs Association (EMCTLA) and its Working Group B 2001-date
Editorial board member, Inside Functional Safety magazine 2010-date
Editorial Advisory board member, Interference Technology magazine 2007-date
Editorial Advisory board member, In Compliance magazine 2005-date
EMCIA representative to BSI GEL 210/12 EMC committee 2009-date
President of the EMC Industries Association (EMCIA) 2008-2010
Vice-President of the EMC Industries Association (EMCIA) 2010-2012
Chair of IEE's EMC Professional Group (E2) 1997-1999



RECENT RELEVANT EXPERIENCE (1990-PRESENT)

Started Cherry Clough Consultants in 1990, Director of the Limited Company since 2010.

External lecturer, Sensors and Electronic Instrumentation MSc course, University of Manchester, teaching an IET-accredited module on practical EMC design techniques, 2002/3 – 2007/8.

The services that Keith provides for Cherry Clough Consultants include:

- Product, system, and installation EMC and safety good practices for reliability and cost-effective regulatory compliance
- Assessment of electromagnetic environments
- Control plans, test plans, etc., for effective management of EMC and safety in projects of all sizes
- Company procedures for EMC and safety, for financial benefits and/or regulatory compliance
- Production / QA procedures for maintaining regulatory compliance in volume manufacture and custom engineering

- Testing and remedial work to meet EMC and safety standards
- Creation of EMC Directive Technical Construction Files and other compliance documentation
- Assessment of EMC Directive Technical Construction Files for a number of EMC Competent Bodies
- Education and training for designers and managers on cost-effective EMC and Safety techniques; and on “EMC for Functional Safety, high-reliability and legal metrology”
- Education and training for executives in EU compliance; liability; financial benefits of using good EMC techniques; and related marketing issues

The above services have been applied in the following areas (not a complete listing):

Systems and installations:

Machinery and manufacturing/process plant of all sizes

Robotics

Air traffic control towers

Computer and telecommunication rooms

Administration centres

Financial dealer rooms

Professional audio systems and installations (e.g. theatres, opera houses, recording studios)

Steel rolling mills

Hospitals

Hotels

Chemical and pharmaceutical processing plant

Nuclear processing plant

Bottling and canning lines

Road tunnel lighting schemes

Broadband-Over-Power-Line (BPL) systems

Synchrotrons (e.g. the Diamond Light Source, Harwell, Oxfordshire)

Railway systems

Mobile X-ray systems for shipping containers

Products and items of equipment:

Industrial instrumentation, control, and machinery of all sizes

Variable speed AC and DC motor drives from very small to 10MW

Automotive engine control units (ECUs) and other electronic subassemblies (ESAs)

Information technology equipment (ITE) e.g. computers, servers, RAID arrays

Personal Digital Assistants (PDAs) and other hand-held wireless-enabled computing devices

Marine equipment

Computers

Photocopiers

Digital Signal Processing

Datacommunications devices

Professional audio consoles and other equipment

Professional video projectors

Lighting

Telephones and telecommunications

Consumer electronics (TV, Hi-Fi, etc.)

Radiocommunications, cellphones and pagers

Lifts (elevators)

Domestic (household) appliances

Gambling machines

Gas boilers

Electricity meters

Electrical power generators (small scale)

Building electrical services equipment

Subsea oil and gas production equipment

Robots

Solar power converters

Military avionics

Medical equipment (various)

Microscope manipulators

Coin mechanisms

Security equipment

Mains-borne communications

Induction heating

Laser welding

Digital microwave radio

Variable-speed winch for a military submarine

PREVIOUS PROFESSIONAL EXPERIENCE (1982-1990)

Keith was mostly involved with the design and development of state-of-the-art capital equipment during the period 1968 to 1990. He has wide experience in electronic product design and project management in the UK, South Africa and France, after finishing graduate apprenticeship with Thorn Automation in 1973.

Technically, he started in analogue design in 1968; adding digital control of analogue circuits in 1978, and A/D and D/A conversion in 1980. Project and departmental management experience

was gained from 1983 onwards, including teams of more than 20 engineers and scientists (this was for the Microwave division of Marconi Instruments Ltd, Stevenage, UK, 1983-1988).

BOOKS, PUBLICATIONS and PAPERS

EMC Design Techniques for electronic engineers

Nutwood UK November 2010, ISBN: 978-0-9555118-4-4, full colour graphics throughout. Order from www.emcacademy.org/books.asp. Covers all electronic applications, with a very practical approach to good design practices that will save time and cost, reduce time-to-market, and reduce warranty costs and financial risks. (Chapter 2 of this book is the complete text of "The Physical Basis of EMC" (below), so don't buy both!)

The Physical Basis of EMC

Nutwood UK October 2010, ISBN: 978-0-9555118-3-7, full colour graphics throughout. Order from www.emcacademy.org/books.asp. Provides an understanding of electromagnetic phenomena, in a way that can be easily understood by practising electronic engineers. (Chapter 2 in "EMC Design Techniques for electronic engineers" is the same text, so don't buy both!)

EMC for Printed Circuit Boards – Basic and Advanced Design and Layout Techniques

Nutwood UK December 2010, ISBN 978-0-9555118-5-1, full colour graphics throughout. (2nd Edition, identical to 1st Edition except for format.) From www.emcacademy.org/books.asp Practical good-practice EMC design techniques for printed circuit board (PCB) design and layout, for designers of electronic circuits and PCB designers themselves. All application areas are covered, from household appliances, commercial and industrial equipment, through automotive to aerospace and military. This book is used by some University courses.

The First 500 'Banana Skins'

Nutwood UK, 2007, 500 reports and anecdotes concerning electromagnetic interference (EMI), collected and edited by Keith Armstrong. Read it at www.theemcjournal.com, or buy from www.emcacademy.org/books.asp. More 'Banana Skins' are published 6 times a year in 'The EMC Journal', available free at www.theemcjournal.com or www.compliance-club.com

EMC for Systems and Installations

By Tim Williams and Keith Armstrong, Newnes, 2000, ISBN: 0-7506-4167-3, www.bh.com/newnes, RS Components part number: 377-6463

Keith has written and presented a great many papers for a wide range of symposia, conferences, colloquia, and seminars worldwide, including ERA, IEE, IET, IEEE EMC Society and IEEE Product Safety Engineering Society events. Too many to list here, please ask for further details.

He has also published a great many articles on EMC for publication in professional journals and trade magazines worldwide, including the following five annual series for the EMC Compliance Journal (now available from www.emcstandards.co.uk):

- "EMC design of Switching Power Converters" (14 parts, 2011-2013)
- "Designing for EMC" (6 parts 2006-8)
- "Advanced PCB Design for EMC" (8 parts, 2004-5)
- "EMC Testing" (7 parts, 2001-2)
- "EMC for Systems and Installations" (6 parts, 2000)

Keith has written 17 informative booklets on electromagnetic phenomena, what they are, what causes them, how they cause interference, and how to test for them using IEC and EN standard methods, plus another 5 booklets on EMC issues in systems and installations, for example: Power Quality, Good EMC Engineering Practices, Variable-Speed Drives, etc. They can all be downloaded for free from www.emcstandards.co.uk.

Please visit www.cherryclough.com for more information.