emc STANDARDS

Another EMC resource
from EMC Standards

Cost-effective EMC & PCB Design for Electronic Products (5-day course)

Practical Electronic Design Techniques for Cost-Effective SI, PI and EMC (3 days)

— *plus* —

Basic and Advanced PCB Design and Layout Techniques for SI, PI, EMC in 2015 (2 days)

A Five-day Training Course

by

EurIng Keith Armstrong
Cherry Clough Consultants, U.K.

Synopsis

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

This 5-day course covers all the issues that most electronic designers need for cost-effective SI, PI and EMC. More specialist course modules are available to customise this course.

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, mechanical and PCB 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

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 the relevant textbooks (see page 7) can be provided at extra cost.

Course Duration

Five (5) full days, for example 9:00am – 5:00pm, but 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

The Physical Basis of EMC at Radio Frequencies

Circuit design
> Digital, analogue, switch-mode, communications

Choice of components

Interconnections (i.e. cables and connectors)

DAY 2

Filtering

Shielding (long version)

Suppressing surges

Suppressing electrostatic discharge (ESD)

DAY 3

Suppressing electromechanical devices

Suppressing emissions of harmonics, voltage fluctuations and flicker

Heatsink design for EMC

Techniques for dealing with poor mains power quality

Integrating wireless communications

Close-field probing techniques which are very valuable for every project stage

Some useful references

DAY 4

The PCB design/layout techniques generally required for good SI, PI, EMC in 2015
- The scope of these layout techniques
- Saving time and money
- Segregation
- Interface analysis, filtering, and suppression
- 0V and power planes
- PCB-chassis bonding
- Power supply decoupling
- Switch-mode power converter layout (AC-DC, DC-DC, etc.)
- Transmission line techniques
- Layer stacking
- Devices with BGA packages and/or multiple DC rails
- Some useful references and sources

DAY 5

Advanced PCB design/layout techniques for good SI, PI and EMC in 2015
- When should we use advanced PCB techniques?
- Future trends and their implications
- Rules of thumb, approximations, simulations
- Virtual design for SI and EMC
- Advanced segregation techniques
- PCB-level shielding up to GHz
- Advanced interface filtering and suppression
- Advanced PCB-chassis bonding
- Advanced PCB planes
- The totally shielded PCB assembly
- Advanced PCB decoupling
- Buried capacitance
- Advanced transmission lines
- Differential transmission lines up to 10Gb/s
- Microvia (high density interconnect) technology
- Advanced crosstalk
- Some tricks
- Electromagnetic Band Gap & High-Impedance Surfaces
- Some useful contacts, sources, references

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

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Chair of IET's Working Group on EMC and Functional Safety	1997-date
Chair of IEEE EMC Soc. Special Committee on Risk Management of EMC	2012-date
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)	2001-date
Technical Panel, IET Functional Safety Professional Network	2003-date
Technical Panel, IET EMC Professional Network	2001-date
Editorial board member, Inside Functional Safety magazine	2010-date
Editorial Advisory board member, Interference Technology magazine	2007-date
Editorial Advisory board member, Compliance Engineering magazine	1998-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 for the Sensors and Electronic Instrumentation MSc course at the University of Manchester, teaching an IET-accredited module on practical EMC design techniques.

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
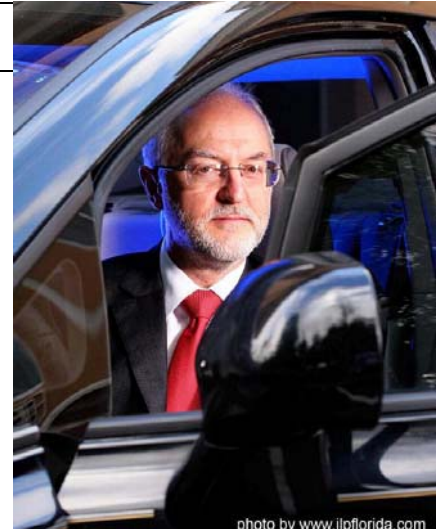
- Production / QA procedures for maintaining regulatory compliance in volume manufacture and custom engineering
- Testing and remedial work to meet EMC and safety standards
- Creation of EMC Directive Technical Construction Files and other compliance documentation
- Assessment of EMC Directive Technical 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 (so far) – please note this is 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 purchase 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 of my book "EMC Design Techniques for electronic engineers" (above) is the complete text of this book, so don't purchase both of them!)

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 (visit http://www.compliance-club.com/keith_armstrong.asp):
- "Designing for EMC"   (6 parts 2006-8, updating the 1999 series)
- "EMC for Systems and Installations"   (6 parts, 2000)
- "EMC Testing"   (7 parts, 2001-2)
- "Advanced PCB Design for EMC"   (8 parts, 2004-5)

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 5 booklets (so far) on EMC issues in Installations, for example: Power Quality, Good EMC Engineering Practices, Variable-Speed Drives, etc. They can all be downloaded for free from www.reo.co.uk/knowledgebase.

Please visit www.cherryclough.com for more information.