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Good EMC engineering for Systems and Installations without EU law (2-day course)

Helping you solve your EMC problems

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Good EMC Engineering Practices for Systems and Installations

— *without* any consideration of legal compliance issues —

A Two-day Training Course

by

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Synopsis

This course describes practical EMC engineering techniques for achieving reliable operation of systems and installations, and also to assist in achieving EMC regulatory compliance. Military personnel might be interested in these techniques for reducing the electromagnetic signatures of sites, and/or improving their resistance to EM warfare.

The use and documentation of good EMC engineering practices for all "*fixed installations*" is a legal requirement in the European Union under the 2nd Edition of the EMC Directive, 2004/108/EC.

Although most of the techniques are described using the example of industrial equipment, systems and sites, they can be used equally effectively for everything that involves connecting electrical or electronic units together with cables to construct systems or installations of any kind, whether fixed or mobile.

This version does not cover the European Union's legal requirements for 'fixed installations' and the equipment and systems used to construct them, under 2004/108/EC.

If you are concerned about legal compliance issue, then we offer an alternative course.

Objective

To provide practical grounding in the EMC techniques that developments in electronic technology have made important for reliability and regulatory compliance of systems and installations.

The practical techniques described here will help reduce project and financial risks when constructing systems and installations that involve electronics.

These techniques will also be of great value to electronic and mechanical product designers, to help them design sub-assemblies and products that can be assembled and installed without

suffering from problems and unreliability. This will also help to reduce warranty costs, which can be a huge drain on profits.

Who Should Attend

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

- Telecommunications (exchanges, networks, etc.)
- Industrial (plants, instrumentation, control, etc.)
- Radiocommunications (base stations)
- Military (sites and vehicles)
- Medical and healthcare (hospitals, etc.)
- Hotels and restaurants
- Information Technology (IT)
- Automotive (manufacturing, vehicles, etc.)
- Infrastructure (water, gas, electricity, telecommunications, internet, etc.)
- Extraction and refining (oil, gas, metals, minerals, mines, refineries, etc.)
- Entertainment (recording and broadcasting TV/audio studios, theatres, cinemas, opera houses, etc.)
- Railway (stations and other fixed sites, vehicles, etc.)
- Marine (harbours, port facilities, docks, container facilities, ships, etc.)
- Aerospace (airports, launch sites, launch vehicles, air/space craft, etc.)
- Science facilities (accelerators, synchrotrons, etc.)

Prerequisites

Familiarity with the design of electrical and/or electronic systems or installations.
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 people attending each course 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.

Copies of the textbook "*EMC for Systems and Installations*" (Newnes, 2000, ISBN 0-7506-4167-3) co-authored by Keith Armstrong and Tim Williams, can be provided at extra cost.

Course Duration

Two (2) full days, for example: 9:00am – 5:00pm each day.

This is a very intensive course with a very large amount of practical detail. In countries where English is not the first language, a longer duration may be preferred.

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.

Reviews of this course

Delegates have always awarded this course an overall score of at least 80%.

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 techniques described to particular projects or products.

COURSE OUTLINE

DAY 1

A) EM phenomena – where they come from, how they can interfere

1. Three parts to every EM interference event
2. Four types of EM coupling
3. EM phenomena in long cables
4. EM phenomena in any conductors
5. EM phenomena associated with electrical power supplies
6. EM phenomena caused by electrical power use
7. EM fields from intentional radiators
8. EM fields from unintentional radiators
9. Electric and magnetic fields from electrostatic discharges
10. EM weapons (Intentional EMI)
11. Comparing immunity test standards with real-life EMI
12. Intermodulation and demodulation
13. Interference with analogue devices and circuits
14. Interference with digital devices, circuits and software
15. Interference with electromechanical devices
16. EMI problems are worsening all the time, because…
17. Some useful references

B) Good EMC practices in the design and assembly of electrical/electronic cabinets

(Using the example of an industrial control panel)

1. Buying electrical/electronic units
2. Following the manufacturer's sensible EMC instructions
3. Following good EMC practices
4. The problem with wires is that they are all antennae now
5. Route send/return current paths together
6. Creating an RF reference plane
7. Routing conductors close to the ‘RF reference plane’
8. RF bonding techniques for metalwork
9. Don’t confuse the reference plane with safety earthing
10. RF bonding techniques for units and PCBs
11. RF bonding techniques for cable screens
12. Choosing and using filters
13. Enclosure shielding and how not to ruin it
14. Choosing and using EMC gaskets
15. Preventing galvanic corrosion
16. Cable classes, segregation, and routing
17. Segregation of units
18. Maintaining EMC in repair, maintenance, and upgrading
19. Information in user manuals
20. Some useful references

DAY 2

C) The real engineering and financial need for EMC

Real-life case studies of where inadequate EMC engineering had serious financial and/or safety consequences

D) CE + CE does not achieve CE, what to do instead

E) Good EMC practices in the design and construction of systems and installations
(For compliance with the 'fixed installations' requirements of the EMC Directive, 2004/108/EC; Lightning Protection to BS EN 62305; and the draft 18th Edition of the IEE Wiring Regulations, BS7671.)

1. Introduction
   - EMC Directive
   - Lightning protection for electronics (BS EN 62305)
   - IEE Wiring Regulations (BS7671)
   - Overview of the overall EMC control procedure
2. Good EMC practices for general use
   - Power distribution systems for EMC
   - Improving power quality
   - Galvanic isolation for EMC
   - Routing send and return current paths together
   - Segregation (zoning) of apparatus and their supplies
   - The bonding ring conductor (BRC)
   - Cable classification, segregation and routing
3. EM Mitigation Techniques
   - EM Zoning
   - Mesh bonding and creating an RF Reference
   - What to do if you can't use mesh-bonding
   - RF bonding techniques
   - The benefits of 'earth loops' ('ground loops')
   - Terminating cable shields at both ends
   - Parallel earth conductors (PECs)
   - Choosing and using filters
   - Cable shielding
   - Shielding for EM Zones
   - Surge and Lightning protection
4. Preventing corrosion
5. Maintaining EM performance over the operational lifecycle
6. Some useful references

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 IET's Working Group on EMC and Functional Safety	1997-date
Reviewer, IEEE Transactions on Electromagnetic Compatibility	2007-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) and its Working Group B	2001-date
Technical Panel, IET Functional Safety Professional Network	2003-date
Technical Panel, IET EMC Professional Network	2001-date
Editor, 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-date
Chair of IEE's EMC Professional Group (E2)	1997-1999

RECENT RELEVANT EXPERIENCE (1990-PRESENT)

Started Cherry Clough Consultants in 1990, currently one of the two Partners.

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 for Systems and Installations, Tim Williams and Keith Armstrong, Newnes, 2000, ISBN: 0-7506-4167-3, www.bh.com/newnes, RS Components P/No. 377-6463.

EMC for Printed Circuit Boards – Basic and Advanced Design and Layout Techniques,
Keith Armstrong, February 2007. Cost £47 plus p&p.
Perfect bound (with titled spine): ISBN 978-0-9555118-1-3
Spiral bound (lays flat for easy use): ISBN 978-0-9555118-0-6
Full colour graphics throughout. Written in a clear concise no-nonsense style full of practical detail. Order via http://www.emcacademy.org/books.asp

The First 500 'Banana Skins',
Nutwood UK, 2007, 500 reports and anecdotes concerning EMI. Edited by Keith Armstrong.

Very useful for have a laugh at other's mistakes, or frightening yourself with what could go wrong. A useful present for a boss that doesn't believe EMC can cause very real engineering and financial problems. Read it at www.theemcjournal.com, or buy from pam@nutwood.eu.com (approximately £10) or via http://www.emcacademy.org/books.asp.

The IET's new (2008) Guide on EMC for Functional Safety
ISBN 978-0-9555118-2-0, colour graphics throughout, cost £27 plus p&p from www.emcacademy.org/books.asp, or free download from www.theiet.org/factfil;es/emc/index.cfm. Written by an IET Working Group chaired by Keith Armstrong, this book comprehensively describes a practical and cost-effective procedure to help to save lives and reduce injuries where electronics technologies are used in all safety-implicated products, systems and installations.

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.

Member of the editorial advisory board for Compliance Engineering Magazine, 1998 - date.

Member of the editorial board for Interference Technology Magazine, 2007 - date.

Please visit www.cherryclough.com for more information.