



Another EMC resource  
from EMC Standards

Good EMC engineering practices for items of  
equipment, with EU law (1-day course)

*Helping you solve your EMC problems*

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# Good EMC Engineering Practices for Items of Equipment

(comprising two or more interconnected  
electronic units in *one* cabinet)

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A one-day Training Course

by

Eurlng Keith Armstrong  
Cherry Clough Consultants, U.K.

## Synopsis

This course describes practical EMC engineering techniques for achieving reliable operation of items of equipment that are intended for use in systems and “*fixed installations*”, and also to assist in achieving EMC regulatory compliance. Military personnel might be interested in these techniques for reducing electromagnetic signatures and/or improving 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, from the 20<sup>th</sup> July 2007, under the 2<sup>nd</sup> Edition of the EMC Directive, 2004/108/EC.

Although most of the techniques are described using the example of an industrial control cabinet, they can be used equally effectively for everything that involves connecting two or more electrical or electronic units together with wires and cables to construct an item of equipment, in a single enclosure of any kind, fixed or mobile (e.g. a motor car).

***This version includes the European Union’s legal requirements for ‘fixed installations’, and for the equipment and systems, whether standard or custom, supplied for use in them.***

## Objective

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

The practical techniques described here will help reduce project and financial risks when constructing equipment, 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 into enclosures, and then be used in systems and installations, 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, nuclear, 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 products, 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 also be provided at extra cost.

## Course Duration

One (1) full day, for example: 9:00am – 5:00pm. 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 extended beyond one day to provide individual consultancy to help engineers or managers apply the material to 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

### A) Complying with the 2<sup>nd</sup> Edition of the EMC Directive: 2004/108/EC

From 20th July 2007, the new EMC Directive has included specific requirements for “fixed installations” (sometimes called systems), and also a special regime for custom-engineered apparatus.

1. Background, and EMC and safety issues
2. Requirements for fixed installations
3. Requirements for equipment and systems intended for supply to fixed installations
4. 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

## Course Instructor

### Academic Qualifications

BSc (Elec.Eng), Upper 2<sup>nd</sup> 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](http://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](http://www.theemcjournal.com), or buy from [pam@nutwood.eu.com](mailto: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](http://www.emcacademy.org/books.asp), or free download from [www.theiet.org/factfil/es/emc/index.cfm](http://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](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](http://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](http://www.cherryclough.com) for more information.