



Another EMC resource  
from EMC Standards

## How to do EMC for Functional Safety (Half-day Course)

*Helping you solve your EMC problems*

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# How to Manage the Functional Safety and other risks\* that can be caused by Electromagnetic Disturbances, by applying IEEE 1848-2020 or IET 2017

(originally called: "EMC for Functional Safety")

\* 'other risks' include high-reliability / mission-critical systems for: defence, security, national infrastructure, banking and investment, legal metrology, etc., and financial issues such as legal liability or reputational risks

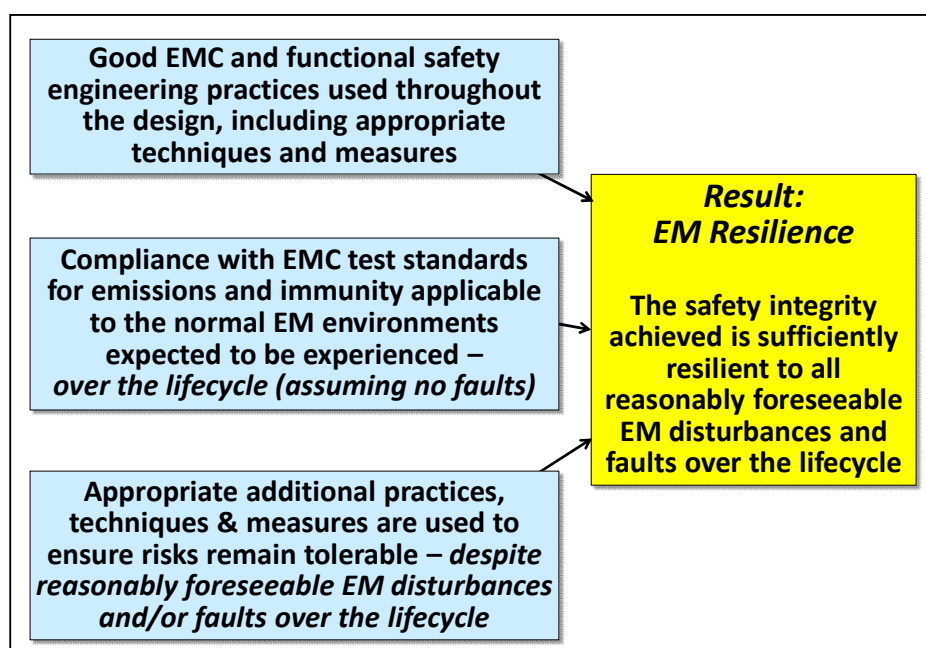
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## A half-day Training Course

by **Keith Armstrong**

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of Cherry Clough Consultants Ltd, U.K.

[www.cherryclough.com](http://www.cherryclough.com) [www.emcstandards.co.uk](http://www.emcstandards.co.uk)



## Synopsis

Training in the good engineering practices required where electromagnetic disturbances could cause errors or malfunctions in electronic equipment which could have implications for functional safety, high-reliability, mission-criticality, legal metrology, etc.

This course is based upon the IET's 2017 "Code of Practice on Electromagnetic Resilience", and on its successor, IEEE 1848-2020 "Standard on Techniques and Measures to Manage Functional Safety and Other Risks with Regard to Electromagnetic Disturbances", both written by IET / IEEE teams chaired by the author.

IEEE 1848-2020 is a 2<sup>nd</sup>-generation development of the IET's 2013 guidance on "EMC for Functional Safety", which provided – for the first time – practical information that allows the cost-effective implementation of techniques and measures relating to electromagnetic disturbances, to help manufacturers comply with the basic functional safety standard IEC 61508 and any of the many functional safety standards that have been developed from it (see list below), ISO 14971 and IEC 60601-1-2 (medical), IEC 61000-1-2:2016 (basic), IEC 61326-3-1, IEC 61326-3-2, IEC 61000-6-7 (industrial), IEC 60335-1, IEC 62368-1, etc.

## Objective

To describe a practical and cost-effective approach to dealing with electromagnetic disturbances that might create electromagnetic interference – EMI – i.e. errors or malfunctions in electronic hardware and/or software, which could possibly implications for functional safety, high-reliability, mission-criticality, legal metrology, etc.

## Who Should Attend

All electronic, EMC and safety engineers (design and/or test disciplines) and all project managers, in all industry areas, including:

Automotive	Medical & Healthcare
Consumer	Household (domestic) appliances
Information Technology (IT)	Industrial instrumentation or control
Railway	Marine
Aerospace	Military, Defence
Telecommunications	Radiocommunications
Mining	Oil and gas production (including offshore)
Machinery	Robotics
Security	Banking, Finance

## Prerequisites

No prerequisites. 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 to aid understanding. Relevant case studies will be included verbally.

Each attendee will be presented with colour PDFs of the PowerPoint slides used during the training, one printed at 2 slides per page (for viewing on a personal digital device), and the other at 6 slides per page (suitable for colour printing). The spaces around the slides usually suffice for taking extra notes. Copies of IEEE 1848-2020 and/or the IET's 2017 Code of Practice can be provided, at extra cost.

## Functional safety standards developed from IEC 61508

IEC 61511, Safety Instrumented Systems for the Process Industry Sector (= ANSI/ISA S84)  
IEC 62061, Safety of Machinery  
IEC 62278 / EN 50126, Railways – Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS)  
IEC/EN 50128, Software, Railway Control and Protection  
IEC/EN 50129, Railway Signalling  
IEC 61513, Nuclear Power Plant Control Systems  
RTCA DO-178B, North American Avionics Software  
RTCA DO-254, North American Avionics Hardware  
EUROCAE ED-12B, European Flight Safety Systems  
ISO 26262, Automobile Functional Safety  
IEC 62304, Medical Device Software  
IEC/EN 50402, Fixed Gas Detection Systems  
DEF STAN 00-56, Accident Consequence (UK military)

## Course Duration

4 hours (including a short break), i.e. half a day; e.g., 09:00 to 13:00, or 13:30 to 17:30.

This course can be very usefully combined with a half-day of discussion/consultancy, making a one-day course overall, to help attendees apply its material to their current or future 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

- 1) Introduction to the modern need for these standards and guidance
- 2) Introduction to their general approach
- 3) Details of their 90+ “Techniques and Measures” for:
  - System and Operational Design
  - Managing the design to avoid errors due to EMI
  - Error Detection & Correction design
  - Design Verification and Validation
- 4) Questions and Answers
- 5) Technical Summary and conclusions

## 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: 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 (Eurlng), FEANI, Paris, France 1988  
Presented with the IEEE EMC Society's new (in 2018) "Excellence in Continuing EMC Education Award" 2018

### Professional Activities

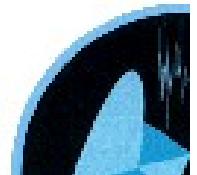
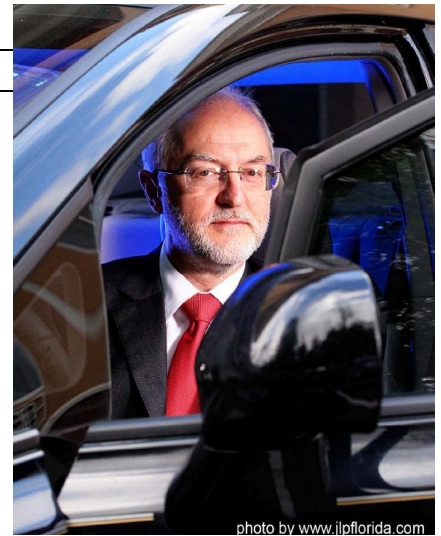
Chair of IEE/IET's Working Group on EMC and Functional Safety 1997-date  
Chair IEEE EMC Soc. Special Committee: EMC Risk Management 2012-2016  
UK expert appointed (by invitation) to IEC maintenance team MT23 on IEC 60601-1-2 (Medical Equipment/Systems EMC) 2006-date  
UK expert appointed (by invitation) to IEC maintenance team MT15 on IEC 61000-1-2 (EMC & Functional Safety: Basic) 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 Working Group B 2001-date  
Editorial Advisory board, Interference Technology magazine 2007-date  
Editorial Advisory board, In Compliance magazine 2005-date  
President of the EMC Industries Association (EMCIA) 2008-2010  
Vice-President of the EMC Industries Association (EMCIA) 2010-2012  
EMCIA's representative on BSI GEL 210/12 EMC committee 2009-date  
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.  
Started EMgineering Ltd (owns [www.emcstandards.co.uk](http://www.emcstandards.co.uk)) and appointed Director, October 2017.  
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, safety, for financial benefits and 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 similar documentation
- Assessment of EMC Directive Technical Construction Files for a number of EMC Competent / Notified 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 systems and installations of all types and sizes

Robotics

Air traffic control towers

Computer and telecommunication rooms, centres, etc.

Administration centres

Financial dealer rooms

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

Steel rolling mills

Hospitals and medical centres

Hotels

Chemical and pharmaceutical processing plant

Nuclear processing plant

Bottling/canning lines, other conveyor systems, etc.

Road tunnel lighting schemes

Broadband-Over-Power-Line (BPL) systems

Railway systems

Mobile X-ray systems for shipping containers

Synchrotrons (e.g. the Diamond Light Source, Harwell, Oxfordshire, [www.diamond.ac.uk](http://www.diamond.ac.uk) )

Fusion reactors, Tokamaks, (e.g. the ITER project in southern France, [www.iter.org/](http://www.iter.org/))

**Products and items of equipment:**

Industrial instrumentation, control, and machinery of all types and sizes

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

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

Battery chargers, from very small up to MW

Power converters: AC-DC, DC-DC, DC-AC, AC-AC, from very small up to MW

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

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

Marine equipment

Subsea oil and gas production equipment

Photocopiers

Digital Signal Processing

Datacommunications devices

Professional audio consoles and other pro 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

Digital microwave radio

Robots

Solar power converters

Military avionics

Military land vehicles

Military submarine variable-speed winch

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

Military land vehicles (to Land Class A)

Wheeled robots for search/rescue and bomb disposal

**PREVIOUS PROFESSIONAL EXPERIENCE, 1968 – 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 a 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

from 1983, with teams of up to more than 20 engineers and scientists (for the Microwave division of Marconi Instruments Ltd, Stevenage, UK, 1983-1988, and for Lock Metal Detectors, Oldham, 1988 - 1990).

### **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.emcstandards.co.uk/books4](http://www.emcstandards.co.uk/books4). 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 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.emcstandards.co.uk/books4](http://www.emcstandards.co.uk/books4). 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 identical, 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.emcstandards.co.uk/books4](http://www.emcstandards.co.uk/books4).

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' (also known as 'EMI Stories')***

Nutwood UK, 2007, 500 reports and anecdotes concerning electromagnetic interference (EMI), collected and edited by Keith Armstrong. Read them for free (and at least 300 more 'EMI Stories') at [www.emcstandards.co.uk/emi-stories](http://www.emcstandards.co.uk/emi-stories), or buy the book from [www.emcstandards.co.uk/books4](http://www.emcstandards.co.uk/books4).

#### ***EMC for Systems and Installations***

By Tim Williams and Keith Armstrong, Newnes, 2000, ISBN: 0-7506-4167-3, [www.bh.com/newnes](http://www.bh.com/newnes), RS Components part number: 377-6463, also available from [www.emcstandards.co.uk/books4](http://www.emcstandards.co.uk/books4).

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](http://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](http://www.emcstandards.co.uk).

Please visit [www.cherryclough.com](http://www.cherryclough.com) and/or [www.emcstandards.co.uk](http://www.emcstandards.co.uk) for more information.