



Another EMC resource
from EMC Standards

EMC Design of Switch-Mode Power Converters (1-day course)

Helping you solve your EMC problems

EMC Design of Switch-Mode Power Converters

including PWM motor drives for *hybrid and electric vehicles* and *renewable AC* power generators

A One-day Training Course

by

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Synopsis

Switch-mode power conversion is an extremely noisy technology, and it is very difficult and costly indeed to suppress its emissions for compliance (and happy customers) unless good EMC design techniques are used from the start.

This course covers EMC design techniques to control emissions from all types of switch-mode power converter, at all power levels (from under 1W to over 10MW), from circuit design and PCB layout to packaging and installation, including:

- DC and AC motor drives for hybrid and electric vehicles
- DC and AC motor drives for domestic appliances, commercial and industrial sites, including steppers and servos
- AC power generation from renewable energy sources (e.g. PV, wind, water, tidal, etc.) and batteries.
- Mains powered AC-DC power supplies and isolating DC-DC converters
- Non-isolating DC-DC converters
- Class D audio power amplifiers
- All types of switch-mode conversion, including AC-DC, DC-DC, DC-AC, AC-AC
- EMC design techniques for circuits, PCBs, mechanical packaging, systems and installations, for converters of less than 1W to greater than 10MW

Objective

To provide practical grounding in the EMC techniques now required for switch-mode and PWM circuits, to help companies quickly improve their commercial and financial performance by:

- Bringing advanced products to market more quickly
- Reducing unit manufacturing costs
- Reducing warranty costs and costs of ownership by improving reliability
- Easily complying with legal EMC requirements
- Reducing financial risks and improving Return On Investment

Who Should Attend

All electronic designers and their managers who are involved with switch-mode and PWM circuits, 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
Agriculture	HVAC
Professional audio/video/broadcasting	

Prerequisites

Familiarity with circuit (hardware) design, PCBs/PWBs and electronic 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 textbook *“EMC for Printed Circuit Boards, basic and advanced design and layout techniques”*, Armstrong/Nutwood January 2007, ISBN: 978-0-9555118-0-6 (spiral bound to lie flat when open) or 978-0-9555118-1-3 (perfect bound), can be provided at extra cost.

Course Duration

One (1) 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 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

- EMC design of AC-DC input rectifiers
- EMC design of chopper circuits
- EMC design of converters that use isolating transformers
- EMC design of AC-DC output rectifiers
- EMC design of PWM AC or DC outputs, for motor drive or renewable power generation
- Power Factor Correction – suppressing mains harmonic emissions
- Suppressing emissions of voltage fluctuations and flicker to the mains supply
- Dealing with Insulated Neutral “floating” mains power systems (e.g. ships, offshore, etc.)
- Some useful references and further reading

Course Instructor

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email: keith.armstrong@cherryclough.com



EDUCATION/CERTIFICATION

Bachelor of Science (BSc) with Honours, Upper Second Class,
Electrical Engineering, Imperial College of Science and Technology,
London, U.K. 1972.

Associate of the City and Guilds Institute (ACGI), London, U.K., 1972

Member of the Institution of Electrical Engineers (MIEE) London, U.K.
recently renamed as The Institution of Engineering and Technology
(IET), since 1977. Appointed Fellow (FIET) in 2010.

Appointed as Chartered Engineer (C.Eng) by the Council of
Engineering Institutions, London, U.K., 1977

European Engineer (Eurlng) Group 1 awarded by the European
Federation of National Engineering Institutions (FEANI), 1988

Member of IEEE (USA) and IEEE EMC Society, MIEEE, 1998

Member of IEEE Product Safety Engineering Society (USA), 2004

PROFESSIONAL ACTIVITIES

President of the EMC Industry Association (www.emcia.org)
2008-date

Chair of IEE's Electromagnetic Compatibility (EMC) Professional Group (E2)
1997-1999

Chair of IET's Working Group on EMC and Functional Safety
1998-date

Member EMC Test Labs Association (EMCTLA) and its Working Group B
2001-date

Member of Technical Panel for IET's EMC Professional Network (PN)

Member of Technical Panel for IET's Functional Safety PN

UK Expert appointed to the maintenance team (MT15) for IEC 61000-1-2
(EMC & Functional safety)

UK Expert appointed to the maintenance team (MT23) for IEC 60601-1-2
(Medical EMC)



2001-date

2003-date

2003-date

2007-date

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.