

TRAINING MODULESⁱ

The Basics				
Module Name	N°	Description	Duration (mins)	Deliverables
EMC – What is it?	1a	This module looks at the basics of EMC in layman's terms, defining the terminology used in this field, looking at the theory of EMC and even touching on Maxwell's equations briefly. It discusses waves and their propagation through space, explains near and far field regions, looks at the types of waves that could be encountered, modulation and its definitions, sources of interference and how equipment receives interference into the system, and reviews radiated conducted, transient voltage and ESD briefly.	90	Glossary of terms Suggested Reading Module Notes
An Overview – Should I do Anything?	1b	Here we look at the reasons behind EMC testing and evaluations. Why should I as a company do any testing at all, what legal requirements are in place to my industry, what could happen to us if I don't do anything. It also looks at the cost of EMC testing and gives examples of the way cost can be increased if not planned properly. A review of the only study of UK field strengths is done (MIRA Report). It looks at warranty and in field failures and finally looks at the standards and depth of the testing briefly before concluding with some case studies of when EMC was forgotten	60	Module Notes
Planning for EMC	1c	EMC isn't just a single persons responsibility or even a departments. The responsibility lies in many areas from management to suppliers. This module focuses on the time line of a development process in general terms and looks at how the company standards, policies, supplier selection and control and design principles all effect the way in which EMC is controlled and delivered effectively. It is across disciplines and briefly looks at packaging Design Verification Process (DVP), 'V' structure design and software tools to help the processes work in unison.	90	Module Notes
EMC Evaluationⁱⁱ				
Module Name	N°	Description	Duration (mins)	Deliverables
System or Vehicle Testing?	2a	It is always a discussion point as to how and when to test the end product or components for their EMC compliance. In Module 1c- a methodology - I discussed this in depth and here we touch on it again in terms of the test requirements for vehicle or system/component tests. A review of relevant test standards is performed. The differences between test methods, when each is appropriate in its use, how to use system tests for investigation on systems, what can be done in house or when it is necessary to outsource the work to specialists.	45	Module Notes

<p>Test Techniques – the Fundamentals</p>	<p>2b</p>	<p>This module explains the fundamentals of testing products from the types of test sites and tests themselves, equipment required, problems and limitations of testing, the types of test available and the importance of geometry. Discussions on test set-up and calibrations of equipment and chambers, resonance's, reflected and direct paths and a brief discussion on measurement uncertainties is all covered. A section on the best types of test is also discussed looking at the various ways to perform immunity i.e. BCI v Radiated as an example. Correlation between tests is reviewed and how the results evaluated is briefly looked at. Finally the way in which the units are operated under test is discussed at length as being vital in the authenticity of the results to the working environment</p>	<p>90</p>	<p>Module Notes</p>
<p>Emissions Testing</p>	<p>2c</p>	<p>Emissions' testing is probably the most skilled point of EMC testing where the operators' knowledge can mean the difference in many thousands of pounds. In this extended module we look at the equipment needed and pros and cons of different types, test set-up and geometry, determining the emissions source and type, detectors and there uses, CISPR requirements, take a long look at the confusing area of broadband and narrowband noise and review the CISPR flow charts on emissions determination. Additionally the use of near field probes is discussed as an aid to testing and the use of automated software and scanners is looked at for component and vehicle testing. Finally some noise revues from various types of sources and the types of noise being generated are performed and the things that can easily effect the generation of noise discussed briefly.</p>	<p>120</p>	<p>Module Notes Break in this module of 10 mins</p>
<p>Immunity Testing</p>	<p>2d</p>	<p>Immunity testing is a more capital-intensive test with specialist enclosure being required for most tests. Here we look at the relevant standards and how to put them into practical use and how and when to test for immunity. Again a revue of the type of equipment required i.e. power meters versus SA are looked at and a simple system developed for immunity testing. The use of Nett and FWD power is explained in its application and the geometry and issues about geometry discussed as being an important factor. The importance of variability in the test set-up and the system is discussed as a major issue with repeat testing and an introduction into project "Change Requests" is discussed.</p>	<p>90</p>	<p>Module Notes</p>
<p>Other Test methods</p>	<p>2e</p>	<p>There are many other tests that fall under the overall title of EMC Testing. Here we discuss the following areas:</p> <ul style="list-style-type: none"> • Reverberant Rooms • Transients • ESD • Voltage Injection • Bespoke Noise generators i.e. relays and spark <p>These are discussed openly and at the required depth of the audience. If a specific topic is required the session will be devoted to that test technique</p>	<p>45</p>	<p>Module Notes</p>

Analysing, Resolving & Reporting

Module Name	N°	Description	Duration (mins)	Deliverables
Evaluating Results	3a	Results are displayed in many ways through figures graphs statements and tabulated data. Here we look at how to decipher test laboratory results whether your own or others results. Immunity reports often have issues relating to resonances and these are discussed at length. A detailed look at powers and levels achieved and how these relate to geometry is again reviewed. How measurement uncertainties and UKAS interpretation of these as applied to results is discussed. Emissions graphs and the plotting of data against levels, detectors and geometry are reviewed and the audience should be able to see the differences and reasons behind plotting emissions results correctly is vital. The determination of emissions noise has already been discussed in 2c and here we see how the types of emissions look when plotted differently on graphs. A look at pass/fail criteria and how these are applied and questions to answer before accepting the results finishes the session	60	Module Notes
Problem Solving	3b	Many issues arise as to how to resolve problems within the development or field-testing, warranty cycles. Modules 1d – e Design Principles will cover the basics of designing components and systems to best effect but here we are looking at reported and found problems, often field failures. The importance of data from testing is expressed and the ability to reproduce the fault is addressed. The use of techniques and tools to find the problem, coupled with in depth knowledge of the system and why this is important are reviewed. Then the use of techniques to rectify the problem in a test environment is discussed including shielding, impedance changing, filtering and software techniques discussed. The importance of corporate policies and good design principles is re-iterated.	90	Module Notes
Reporting Results	3c	This short module looks at how to display results effectively and concisely to managers, engineers, customers and official bodies requiring evidence. I discuss formal reporting and what needs to be shown, certificates of pass/fail and summary information all of which could apply to the same test data.	30	Module Notes
Legislation Requirements	3d	Legislation doesn't just start when the results have been produced but starts again at the policy side of the company. How do we select products for final testing, how do we get them witnessed or approved what happens if I change the design, communications with official bodies and the quality system are discussed. Additionally this section looks at the various standards applying to the product you are manufacturing, testing or developing. This includes British, European and Global standards and includes a specific discussion on the North American requirements. To meet these requirements it does not only depend on the results of the tests but how and when they were performed and the modes of operation	90	Module Notes

<p>Implementing 2004/104/EC</p>	<p>3e</p>	<p>This module introduced in September 2005, looks at the specific implementation of the new automotive directive and its impact on testing and evaluation. The module looks at:</p> <ul style="list-style-type: none"> • 72/245/EEC and 95/54/EC and its revisions • Changes in Emissions and Immunity requirements and the use of internationally recognised standards • Introduction of Transient Testing • Changes in administration required by your company • The timings and implementation requirements • CE marking as part of the Directive and how it is applied • Monitoring and functions of systems under test • The Technical Services new role 	<p>165</p>	<p>Module Notes Break in this module of 15 minutes and is split into a 60 minute and 1 hour 45 min sessions</p>
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EMC Management

Module Name	N°	Description	Duration (mins)	Deliverables
<p>How does EMC Affect Me?</p>	<p>4a</p>	<p>EMC isn't just a Electronics responsibility but that of all the designers, manufacturers and managers of the process. A discussion on the need for good policies and process has already been briefly covered but here we start to look at this deeper. The use of materials and their changes in design, enclosures and alterations for non-electrical reasons (aperture changes) are seen as important issues to the effectiveness of the EMC of the product. Routing of wires in vehicles and the positioning of critical systems and intentional radiators is discussed in depth and the idea of "EMC – Nothing to do with Me" is dismissed</p>	<p>60</p>	<p>Module Notes</p>
<p>DVP Management – A Route to Success</p>	<p>4b</p>	<p>The area of DVP management and its control is a vital one for the operation of a good EMC design, manufacturing and in service process. The DVP process including all the various stages of a generic process is discussed and includes areas such as:</p> <ul style="list-style-type: none"> • Supplier Control • Test Requirements for Suppliers • Timing Schedules for various production platforms • Architecture Management • Strategies on Fusing, packaging and installations • Worst Case Studies • Key Points in cycle i.e. Design Freeze or Hard Tooling Freeze • After market issues • Using Change Requests • Informing Authorities of significant changes • Evaluating costs of the process • Quality Systems needed <p>The process is generic and can be modified to a particular requirement of the company and discussions on how specifics fit into the process can be discussed. Finally the use and introduction of software based process control systems is discussed and reviewed on how this would reduce overall costs and introduce quality records and control.</p>	<p>120</p>	<p>Module Notes</p>

EMC Design (Components and Systems)

Module Name	N°	Description	Duration (mins)	Deliverables
EMC Fundamentals	5a	<p>This module provides the designer with the necessary background information in preparation for the EMC Design course (it has already been covered in the main training days and will be used as a refresher for those participants doing a full 4 day course). It discusses the dB and its frequent use in EMC for power, voltage and current measurements, explains the concept of making measurements in the frequency domain, and explains radiated/conducted immunity/emissions, transient voltage disturbances and ESD. The module defines typical threat levels and sources for electronic systems in different environments and describes typical failure modes for different types of threat. We then move on to explain how external threats couple into an electronic system and how internally generated emissions will couple into the environment.</p>	60	Suggested Reading Module Notes
Circuit Design	5b	<p>This module describes in detail all the variables that need to be taken into account when designing at circuit level. The module is broken down into the following distinct elements:</p> <ul style="list-style-type: none"> • Digital • Analogue • Power switching • Power supply • Multiplexing <p>The module defines a consistent approach to how each one of these elements should be treated, giving examples of good and bad design to illustrate the points.</p>	90	Module Notes Typical good and bad designs with explanations
I/O Filtering	5c	<p>Now the functionality of the design is completed, this module defines how the system I/O should be treated with respect to EMC. The emphasis here is to describe how good focused design can meet the defined threat requirements without over-engineering. A detailed look at I/P and O/P filtering is covered with examples of commercially available types of filters introduced and examined</p>	60	Module Notes
PCB Design - Partitioning & Layout	5d	<p>With the schematic design finalised, attention now moves to the PCB. This module describes how the design can be broken down into distinct different signal groups and physically partitioned on the PCB. Once partitioning has been optimised the module continues to describe how the PCB traces should be laid out, defining key guiding principles to a robust design.</p> <p>Additionally, this module defines in detail, design considerations for a PCB. The following elements are dealt with individually:</p> <ul style="list-style-type: none"> • Stack-up • Grounding • De-coupling 	120	Module Notes

		<ul style="list-style-type: none"> • High Speed Digital • Microprocessor • FPGA • Daughter-board 		
Interconnects & Cables	5e	This module deals with intra-system and inter-system interconnects and cables, defining the variables that should be considered when making decisions on cable/connector types. This includes the types of cables from screened cables to single wires, earth return requirements, connector shielding, and also covers routing and cross over issues.	30	Module Notes
Enclosure design & shielding	5f	This module describes how the enclosure performs as an integral part of the overall EMC design which is often overlooked by the electronics designer. Examples of shielding enclosures, methods of reducing EMI leakage, commercially available products for these areas and techniques to reduce EMC problems are discussed and evaluated.	30	Module Notes
Software	5g	The module describes how significant software is to the overall EMC performance of a system and how it can be used to optimise the system EMC performance often resulting in the reduction of unnecessary filtering hardware.	30	Module Notes
System Design Issues	5h	<p>This module looks at the issues to be reviewed during a system design process with special emphasis on the systems EMC performance. Most of the issues will have been dealt with in some way but here we concentrate on things specific to the system. This includes:</p> <ul style="list-style-type: none"> • Earth straps and dimensions • Routing and distance from metallic parts • Crossing of cables • Bundling and location of wires • Voltage Drop • Ground Shift • Multiplex signal degradation 	60	Module Notes

ⁱ All modules are designed to be interactive and for the students to ask questions at any time therefore timings are approximate

ⁱⁱ Please note that EMC testing modules can be accompanied by actual tests at accredited laboratories in the UK or Germany. Additionally, training on the test techniques can be performed at the customers premises (certain tests only if being performed outside of a shielded enclosure) and the hire of the equipment will be charged at cost with a 10% handling charge