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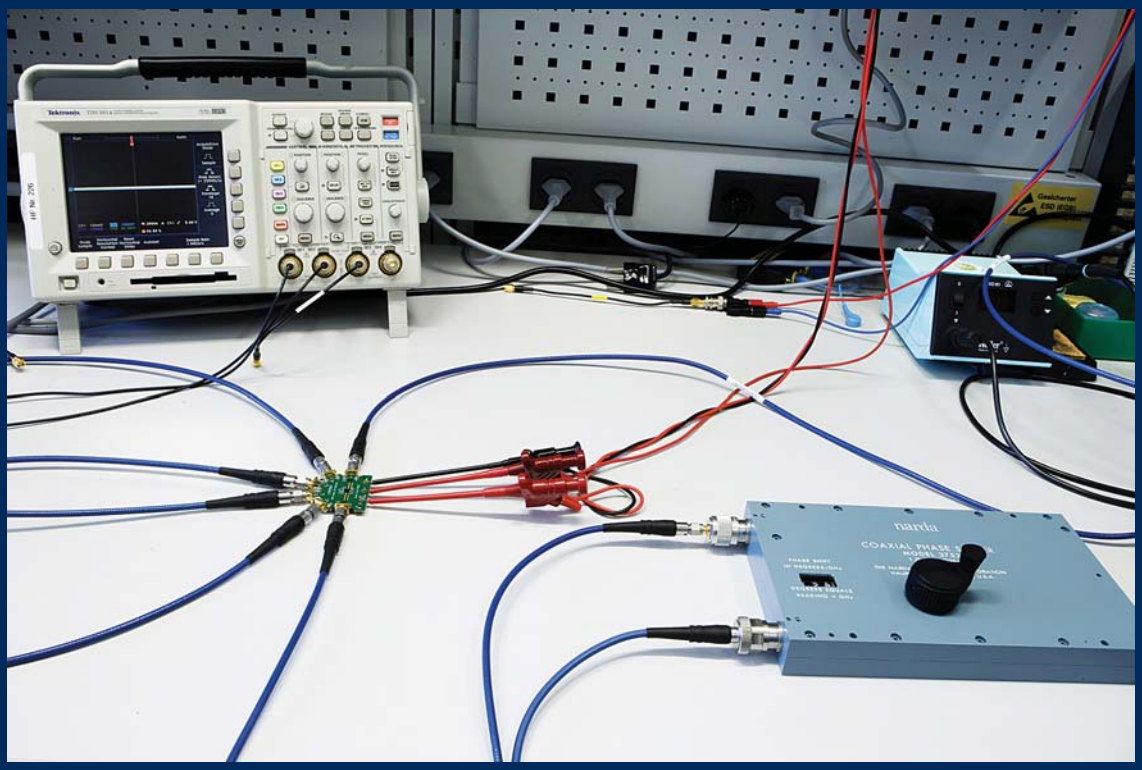

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EMC UK 2011

EMCUK 2011
11 & 12 October
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www.emcuk.co.uk

Cameron & Prisk snub Trade Association
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ROHDE&SCHWARZ

What's In This Issue

MILMEGA

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Downing Street & BIS Snub Trade Association

It seems that despite the massive amount of tax payers' money supporting the offices of David Cameron the Prime Minister and Mark Prisk Minister of State for Business and Enterprise they cannot find the time to answer a serious letter on the PLT Saga from a bone fide UK Government Accredited Trade Association… the EMC Industry Association (EMCIA).

A letter was sent on the 19th May 2011 to both Cameron and Prisk, also to Ed Vaizey MP Minister for Culture, Communications and Creative Industries. On the 2nd of June a reply was received from Downing Street which simply said… I am writing on behalf of the Prime Minister to thank you for your letter and enclosure of 19th May. Your correspondence is currently under consideration. Signed with a squiggle, Correspondence Officer. There was no Subject or Topic Reference as to who any further correspondence could be addressed.

Subsequently on 1st July copies of the original letter were sent to Cameron and Prisk asking for some response. At the time of going to press Friday 16th September this letter has been completely ignored… not even acknowledged. At the very least rude and unprofessional but we guess the sort of behaviour we can now expect from MP's. In fairness to Ed Vaizey he did have the courtesy to respond although declined any meeting due to diary commitments.

So the perception is that Cameron and Prisk have some ulterior motive for ignoring PLT and supporting a lame duck not fit for purpose Ofcom decision. What that motive might be is anyone's guess.

The aforementioned letters can be read on the EMCIA Web site and the current PLT saga is clearly explained on pages 7 to 9.
www.emcia.org

Aircraft Electromagnetic Certification Workshop 2011

The QinetiQ Electromagnetic and Environmental Services (EMES) Group is very pleased to announce that the Aircraft Electromagnetic Certification Workshop (AECW) 2011 will be held at QinetiQ, Cody Technology Park, Farnborough, Hampshire, GU14 0LX from the 22nd to 25th November 2011. Acting on extremely positive feedback from the previous courses, the workshop is now conducted over four days to allow more time for interactive sessions and tutorials.

Prof. Nigel Carter will once again be our lead trainer for the workshop and brings over 40 years of aircraft electromagnetic certification experience. Prof. Carter will be accompanied by other key speakers from the CAA, QinetiQ and BAE Systems. As always live demonstrations of test techniques and actual examples will be provided.

If you are interested in the stringent electromagnetic certification requirements for modern aircraft and avionics systems, including EM immunity requirements (such as High Intensity Radiated Fields (HIRF)) and test techniques then this workshop is for you. The workshop content has been modified this year to serve a growing interest in military aircraft certification requirements and includes interactive sessions to develop the delegate's understanding in the material presented. Presentations on the UK's centre of excellence for military aircraft release located at Boscombe Down, a tour of the UK's largest reverberation chamber and full workshop notes will be included within the delegate fee. For further details or to register your interest in attending AECW 2011 please e-mail: rwhite1@qinetiq.com or call the EMES business group on +44 (0) 1252 392612.

AECW 2011 is Technically co-sponsored by the Institution of Engineering and Technology (IET).

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Secretariat for EMCIA

emcia
Electromagnetic Compatibility Industry Association

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News and Information

Rohde & Schwarz UK celebrates 40th Year

Rohde & Schwarz marks 40 years of service to the UK electronics industry.

When Rohde & Schwarz first entered the UK market, it was characterised by its fierce competition and fast moving technology; factors that haven't changed today. "The UK harbours some of the most creative and talented minds in the electronics industry, and we firmly believe that the business we have built to serve these minds has firm foundations for another forty years and more," said Frank Mackel, Managing Director of Rohde & Schwarz UK (RSUK).

Rohde & Schwarz first entered the UK market in 1954, appointing Aveley Electric as their distributor. In 1971, Rohde and Schwarz purchased Aveley Electric and made a commitment to build a long-term presence in the UK. Forty years on and RSUK's competences have broadened considerably. Today, Rohde & Schwarz UK is a sales, service and solutions provider to customers in the fields of test & measurement, radio & TV broadcasting, IT security, radio-monitoring and radiolocation, as well as mission-critical radio communications.

RSUK has been able to build an industry-leading team of sales and applications staff. By ensuring that customers communicate directly with well-trained technical staff for support and product modifications, RSUK has been able to ensure UK customers receive impeccable service and a voice in guiding

Rohde & Schwarz product development. RSUK's local service organisation is another source of company pride today and an important differentiator from the competition.

An important milestone for Rohde & Schwarz' success in the mobile communications market was when the BT-Cellnet and Racal-Vodaphone joint-venture was looking for a supplier to build the world's first Type Approval System for GSM mobile phones. RSUK won the contract for Munich to build the system and also completed much of the software development. With demand for mobile phone production test systems soon taking off, wireless handset testers became a key constituent of Rohde & Schwarz' product portfolio.

RSUK relocated to a purpose-built facility in Fleet on 1st January 1990, moving closer to many customers within the Armed Services community, including the Ministry of Defense (MoD). In the 1990s, RSUK competed successfully against indigenous manufacturers to win several large contracts from the MoD, including Avionic Radio Test systems for the RAF that are still in service today. In the following decade, RSUK has supplied secure communications systems for among others, Royal Navy Fast Offshore Patrol Vehicles and Tornado aircraft, as well as Merlin and SeaKing helicopters.

Rohde & Schwarz' firm commitment to the UK market has won custom in other domains. Among the many organisations that RSUK has worked with is BBC Engineering, which awarded RSUK a contract to install the first 30 UHF TV relay systems throughout the UK. Being able to offer a turnkey solution thanks to the capabilities of RSUK's Services division, which provides the installation and commissioning expertise to complement our transmitter technology, was key to the deal. Today, Rohde & Schwarz is the main supplier of broadcast transmitters in the UK with over 900 transmitters installed.

After 40 years, RSUK remains an independent company with a commitment to always deliver – a commitment that is shared by Rohde & Schwarz UK's parent company. Our aim is that the trust-based relationships that RSUK employees create with customers will see them continuing to choose Rohde & Schwarz well into the next century!

www.rohde-schwarz.co.uk

See us at EMCUK Stand 12/13

T & M Specialist

MDL Technologies is a company based in Hertfordshire specialising in offering test and measurement solutions within the EMC, RF, Antenna and Power Electronics market sections from proven World-class suppliers. These include exclusive UK and Ireland agreements with ETS Lindgren, Chroma and Milmega, who have specifically chosen MDL Technologies through their in depth knowledge of the market place and customer requirements.

As an independently owned and operated company, MDL are able to offer competitive priced solutions in a rapidly changing and cost effective environment. Managing Director Mark Lucock said, "Having been actively involved within the RF and EMC business for over 25 years it was becoming more apparent that being able to offer customers a flexible and focused knowledge based approach was required. With many companies being merged or taken over, good old-fashioned interactive dialogue is still something our customers appreciate. Having built strong working relationships with our principles has enabled this approach to provide customers with complete proven solutions at competitive pricing".

The MDL philosophy to provide customers with reliable leading technology solutions was recently evident when the Chroma bus tour took place in the UK. Supported by Chroma, whose European Headquarters are based in Holland, a fully equipped bus toured leading UK Power Electronics users displaying fully working power solution systems for customers to use and discuss. A rare event when the solution came to the customer and not the other way round. This has proven to be both innovative and highly appreciated by all concerned.

So in conclusion, MDL are continuing to look for new approaches & to offer customers solutions to old problems using new technologies. Customer service, support and understanding the requirements are our core business principles. To contact MDL Technologies and find out what we can offer, call 01462 431981 or visit our website at

www.mdltechnologies.co.uk

See us at EMCUK Stand 28

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Professionals against Powerline:

The EMCIA gets involved

Over the last few years EMCIA members have become increasingly aware of the threats posed to society in general and to the EMC Industry in particular by Power Line Telecommunications – the high data rate version on the HF and VHF radio bands of course; not the low-rate version in accordance with EN50065 that operates with so little trouble.

Updates on PLT have been featured at most meetings of the EMCIA. In 2009 and 2010 the Standing Committee made inputs at short notice to a Consultation on the future duties of OFCOM, to a Parliamentary Committee on Broadband, and to an OFGEM Consultation on the ambitious plans for "Smart Grid".

Keith Hodgkinson of BIS addressed the meeting in December 2010, but made only minimal reference to PLT!

EMCIA's Chief Executive has pressed Trading Standards to take up certain open-and-shut cases of interference from domestic PLT in an attempt to pin down the relative responsibilities of BIS and OFCOM, and has written to Mark Prisk, Minister of State at BIS seeking a meeting to discuss the enforcement of the "Essential requirements" of the EMC Directive. Prisk is too busy! A letter to David Cameron that criticized OFCOM's position and focused on the conflict of loyalties between their rôles as EMC regulators and as supporters of the telecommunications industry did not receive a meaningful reply.

Why is EMCIA so concerned?

Regular readers of this Journal will know much of the PLT story. Visitors to EMCUK in 2009 and to the website since then will have seen the "Greedy PLT booklet". There is an excellent database at www.compliance-club.com and in the members-only section of www.emcia.org, which has the full text of the letters sent to Downing Street and BIS.

In summary, however, high data rate PLT has claimed the right to ignore existing Emission Standards by a factor of around 40dB – about a 10,000 fold power excess – and used the Technical File (or EMC Assessment) route in the EMC Directive to bemuse and paralyse national regulatory authorities. This process has been supported by effective action to convince the officers of the European Commission that PLT is "good for business" and "a valuable driver for economic growth".

EMCIA, as a recognised Trade body whose members are professionals involved in EMC design and test, and in the manufacture of the components and systems that underpin the 21st century Information Society, has identified the following key problems with PLT;-

- The high transmit level causes local interference to nearby short-wave radio reception. The number of victims is said to be small because complaints are few – but the interference is difficult to identify, the route for complaint is not well signposted, and Britons do not habitually complain. The level of complaints is best summarised by noting that PLT complaints logged by OFCOM are exceeded only by those due to deliberate abuse!

- This high transmit level will, as the number of PLT installations increases, raise the general background level of interference. It has already been demonstrated that even those bands protected from PLT do in fact suffer, due to "intermodulation" effects from rectifiers in the mains network. The radio transmissions from these millions of PLT devices will be propagated world-wide. There will be nowhere to hide from PLT interference, and radio communication and broadcasting will require unaffordable and unsustainable power levels.

- The effect on the credibility and future relevance of EMC Standards is also important. Credibility has already been seriously undermined. Why should the cost of any other product be raised to ensure compliance with the relevant Standards when there is the example of an industry marketing millions of non-conforming products? How can any EMC specialist advocate conformity to Standards so as to maintain a level playing field in the marketplace, when there is another player who has rewritten the rules to suit himself? The resulting upward creep of electromagnetic pollution will eventually nullify the advantage that PLT has seized and just leave a permanently damaged electromagnetic environment.

- A situation has been created where everyone is passing the buck on regulatory action. Trading Standards Officers, funded by local Councils, feel that their priority is Consumer Safety and that they have neither the budget nor the expertise to take action. If they do investigate then they conclude that there will soon be a Standard that will fix the problem, and that radio interference is for OFCOM to deal with. BIS say that the regulations allow OFCOM to handle EMC issues "insofar as action relates to the protection and management of the radio spectrum". OFCOM say that there is no evidence of a significant problem, nor of a breach of the Essential Requirements of the EMC

Directive. Both statements have been widely derided. OFCOM's website refers complainants to the BBC, who are actually only concerned with interference to the BBC's own services, which for listeners in the UK do not use the HF band which is occupied by today's implementations of PLT. Most importantly to the EMCIA, OFCOM's updated statement on PLT found that *"there has not been a breach of the EMC requirements. Considerations … were that the testing and analysis is complex and highly technical. For this reason there is uncertainty as to when products fail to meet the essential requirements."* This "complex and technical" process underpins the very existence of EMCIA and this view cannot be allowed to go unchallenged. The practical effect of the present positions of our regulators is that the "placing upon the market" requirements of the EMC Directive are not being enforced for this particular class of product.

- Smart metering and Smart Grid implementation has the potential for a hundred million in-home installations, together with access PLT to match. This would make the situation at least a hundred times worse – and Smart grid is a EU and UK Government priority. EMCIA experts have put together a report for the Smart Energy Special Interest Group covering all aspects of EMC likely to be of importance to the Smart Grid project, including a realistic assessment of the relative merits of LF and HF/VHF PLT.

At the May 2011 meeting of the EMCIA it was resolved to form a Working Group on PLT. The first action of the Group was to establish the Association's voting position at the UK's National Committee GEL210/11 on the proposed European PLT emission Standard FprEN50561-1. Details of this Standard are set out in the Table opposite, but in brutal summary it legitimises a maximum level of mains-borne emission a few dB ***greater*** than present-day usage and introduces "mitigation measures" most of which have not been demonstrated under real-world conditions, and which even if they do work as hoped would not approach the "protection of radio services" objectives of CISPR and the ITU-R. There are also test requirements that could be met by a design in which that feature provides no operational benefit.

The Standard would sabotage the level playing field for interference that is inherent in today's EMC Standards and Regulatory Guidelines.

EMCIA was one of the three organisations in the UK who voted "No" to the FprEN at the recent meeting of the BSI product EMC Committee, and consequently, in accordance with its rules, the UK abstained in the European vote.

As this issue goes to press, we learn that the CENELEC overall vote is also "No", taking us into uncharted waters. As well as the expected opposition from those concerned with the electromagnetic environment, the quality of the Standard and the credibility of the Standards-making process *there was opposition from PLT manufacturers*. Having been allowed to do as they like for many years, these Companies do not now want to be forced to conform. One cannot blame them: In a capitalist society it is proper for them to make money by exploiting innovation. The CISPR position - "must allow radio to function as intended" - has been equally proper. Today's situation is clearly the result of the failure of the Regulatory process; failure over the last fifteen years of the EU and of our OFCOM and BIS to enforce the existing Standard EN55022 unless or until it is changed.

The Regulatory position that "there will soon be a Standard that will make everything alright" is now obviously ill-founded, and there needs to be serious action by these regulators to bring PLT supporters into negotiations about a Standard recognising that substantial concessions on their part are necessary to allow their business to continue. Technically these concessions need not be difficult but they do require a significant mind-shift.

The future course of PLT Standardisation is very uncertain, but the Association will continue to seek a broad-based Industry position with technical integrity. This will be promulgated using EMCIA's wide contacts and Trade Association status.

Note to other Editors:

The substance of this article has serious implications for the UK Electronics Industry. As such we would encourage you to reproduce the article in its entirety or any of the relevant parts.

If you would like to meet or discuss with any experts from EMCIA, please contact the Secretariat, Pam Hutley at emcia@emcia.org and we will be only too pleased to make the arrangements.

About EMCIA

The EMCIA was formed in 2002 for the benefit of companies and organisations involved in Supplying, Designing, Testing and Manufacturing EMC products and services.

EMCIA is friendly trade association that's all about Networking, keeping you informed, providing marketing & promotional opportunities and hopefully assisting you to increase sales.

If you would like to join just email: emcia@emcia.org

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Electromagnetic Compatibility Industry Association

www.emcia.org

Overview of FprEN50561-1:2011 Power line communication apparatus used in low voltage installations – radio disturbance characteristics –limits and methods of measurement – Part 1: Apparatus for in-home use
With interposed comments in italics

1 Scope

Applies to equipment that transmits in the frequency range 1.6065MHz to 30MHz, *leaving limits at higher (and lower) frequencies and in other environments to be set out at a later date.*

4 Conducted disturbances at AC mains power ports.

These exclude such ports also used for PLT, and are required to meet EN55022 class B limits.

5 Conducted disturbances at telecommunication/network ports.

These are required to meet EN55022 class B limits using EN55022 measurement methods.
This raises questions about the reproduceability of the EN55022 test method under conditions of high symmetrical-mode emission on an associated PLT port; See reference.

6 Conducted disturbances at PLT ports.

These are required to meet the equivalent of EN55022 class B mains port limits;

- between 150KHz and 1.6065MHz for **any** operating condition.
- within the "Permanently excluded frequency ranges" of Table A1. *These comprise Amateur and aeronautical bands.*
- within the "Permanently or dynamically excluded frequency ranges" of Table A2. *These comprise Broadcast bands.* As an alternative to permanent exclusion manufacturers may meet the **Dynamic Frequency Exclusion** requirements of para.6.2 in these ranges.
- When at least 15 minutes have elapsed since the last transmission of "user data". *When PLT forms part of a multi-layer communication system this"user data" will not be the same as "end user data" and so the requirement may be of limited benefit.*

When all the above conditions are absent, the PLT function may employ the substantially enhanced symmetrical mode transmission signal of up to 105dBµV (PK) or 95dBµV (AV) in 9KHz bandwidth [Table 2]. These figures equate to 39dB in excess of EN55022. *This level is some 5dB higher than present PLT practice, and ignores the principal thrust of objections to PLT technology over the last 14 years.*

Such a high level challenges the credibility of this Standard and of the whole fabric of EMC Standards, and provides a clear justification for future disregard of Emission Standards for all products and systems, and for the down-grading of EMC design and test. This will spoil the consumer's experience of electronic equipment – and nullify the signal/interference advantage that PLT seeks to achieve with the present document.

As mitigation, a **dynamic power control** function shall be implemented that is capable of reducing the transmission signal to 75dBµV (PK) or 65dBµV (AV) when the mains network transmission loss is sufficiently low. *The requirement is to be met with a test network [Figure 4] of flat frequency response and the manner of its function with a real-world irregular frequency response is totally unspecified.*

Additionally, in order to ensure the inherent symmetry of the PLT port it shall under all conditions comply with an unsymmetrical emission limit based on EN55022 but using a special ISN [para. 9.4 and annex B] of high longuitudinal conversion loss.

6.2 Specific requirements for Dynamic frequency Exclusion

The Draft sets out requirements for the reduction of PLT power to EN55022 levels upon the detection of a "valid" broadcast signal. This reduction may be implemented according to the ETSI method [Annex C of FprEN50561-1] which may be subject to patent rights. *There has never been any demonstration of this method under conditions of interference form other sources, and there is no specification of an appropriate interference environment during the test.*

Alternatively "Cognitive frequency Exclusion" is introduced as an option without definition [para. 9.3] and "other options are under development."

7 Radiated Disturbances

These are required to meet EN55022 class B limits that are specified at 30MHz and above.
This raises questions about the reproduceability of the EN55022 test method under conditions of high symmetrical-mode emission on an associated PLT port.

Annex A Excluded frequencies

The tabulated frequencies that are to be protected by notches do not include those used for Standard frequency and Time/ Radio Astronomy/Automatic link Establishment for long-distance HF services/Short range devices
Notching (and band edge limitation) has been shown to be ineffective in some circumstances due to in-filling by intermodulation of the high levels of interference on other frequencies. Notching is incompatible with satisfactory protection of radio services in the presence of mass-market HF PLT at the maximum level allowed by this Standard.

Banana Skins...

Editor's note: The volume of potential Banana Skins that I receive is much greater than can possibly be published in the Journal, and no doubt they are just the topmost tip of the EMI iceberg. Keep them coming! But please don't be disappointed if your contribution doesn't appear for a while, or at all. I need at least eight pages in every EMC Journal just to keep up!

653 Northern lights blight satnav

Motorists have come to rely on their sat nav to get them from A to B. Unfortunately, interference from the aurora borealis, or northern lights, can degrade the quality of the GPS signal, making sat navs less accurate, say researchers at Lancaster University. They have created a live AuroraWatch website at tinyurl.com/n7ssx that will email you warnings of any suspect auroral activity. Your sat nav is likely to be affected only if near the Earth's magnetic poles or in about five years' time when we reach the peak of the solar cycle.

(Taken from "Northern Blight", The Sunday Times, 13 July 2008, www.timesonline.co.uk/ingear)

654 Microwave cookers blight Wi-Fi

For example, this could be used for microwave ovens, which frequently impair WLAN communications in the frequency range from 2400MHz to 2500MHz.

(Taken from "Accurate Detection of Impulsive Electromagnetic Disturbance" by Jens Medler and Matthias Keller, Rhode & Schwarz GmbH, The EMC Journal, July 2008, page 27, www.theemcjournal.com)

655 Surge overvoltages blight industrial electronics

A recent study by a European insurance company found that, of the 77,000 items of industrial electronics evaluated, the most common cause of failure was surge overvoltage. Surge damage contributed to 28% of failures, while the next most significant category, lack of maintenance, contributed to 25% of claims.

(Taken from "Are you doing enough to protect your assets?", by MTL Surge Technologies, in Electrical Engineering, March 2008, page 27, www.connectingindustry.com/story.asp?storycode=184484)

656 Scooters blight digital TV

When I watch digital TV channels from terrestrial transmitters, I have to endure periodic disruptions during which the audio and images start stuttering. I recently realised that the disturbance occur every time motorbikes – particularly scooters – pass my house. It doesn't happen with cars. How do scooters disrupt my TV?

(*A question by Michael Smith, posed in "The last word", New Scientist, 22 October 2008, http://www.newscientist.com/blog/lastword/2008/04/on-blink.html)*

657 Dissimilar metals blight shielding

Here's a historical example from your author's experience. Years ago, imported personal computers sometimes used zinc finished sheet metal chassis connected to a cover of similar material with beryllium copper spring fingers.

These materials are far apart on the galvanic scale. After a fairly short time – days to weeks – the shielding performance deteriorated noticeably, and higher radiated emissions would be seen. Upon disassembly, a fine dark line of corrosion could be seen at the contact between the materials.

The zinc, being less noble than the spring finger material, would corrode. In addition, the contact area was minimal, consisting of a line where the fingers curved against the case. When the case was flexed, or if it were disassembled and the surface cleaned, the shielding effectiveness would return to its original level.

(Taken from "EMC Design for Compliance – Enclosures", by the Editors of Conformity, in Conformity magazine's 2008 Annual Guide, www.conformity.com)

658 Pelican crossing blights pre-payment card's cash

Consider the case of Mrs Shirley Jones. Who lives in Cannock, in Staffordshire. She has a pre-payment meter for her domestic electricity usage. Her supplier is RWE, who own N-power.

Each week Mrs Jones puts credit into her top-up card at the local shop.

One week she changed the shop she goes to. To get back home from the store, she needed to use a pelican crossing. When she got home, and slotted it into her meter, she found that her card had absolutely no credit on it. Which it most certainly did have, even before she topped up the overall amount at the shop.

"I thought that was a bit weird. So I went back to the shop. They confirmed that the money had definitely been put onto my N-Power card", said a puzzled Mrs Jones. "We went through all the possible causes of my card having been wiped, and eventually the manager discovered the culprit. It was the pelican crossing I had walked past on my back from the shop. Apparently the electronic beeps in the pelican crossings have the capacity to wipe these top-up cards, simply by you walking past them with the card in your hand," she concluded.

I gather that on this occasion RWE did in due course refund the money. But it does make me wonder just how many other poorer households are being surcharged in this curious way? I do not know. But I think we should be told.

(Taken from "Wiped out by a Pelican crossing", in the "opinion" section on page 10 of Electrical Review, May 2008. For readers who are not familiar with the UK's Pelican crossings, please visit http://en.wikipedia.org/wiki/Pelican_crossing. We know that we don't have EMC standards that actually ensure EMC, but it becomes a bit more than annoying when EMI wipes out our electronic cash! – Editor.)

659 LED lamps blight DAB radio reception

I just switched on all my LED MR16 lamps, and found that one of my neighbours (the other one doesn't have DAB) had no reception. I then switched them all off again, and DAB reception in his house was fine again.

(From an email correspondence with the Editor, 5th September 2011. The author lives in the UK and wishes to remain anonymous.)

660 Harmonic distortion blights plant equipment

Harmonic distortion can cause untold damage to plant equipment. But this problem can be solved using frequency converters, as in the case of a nickel plant that uses low harmonic drives from ABB. On three separate occasions, over a two-year period, Pertti Sihvonen experienced

Continued on page 12

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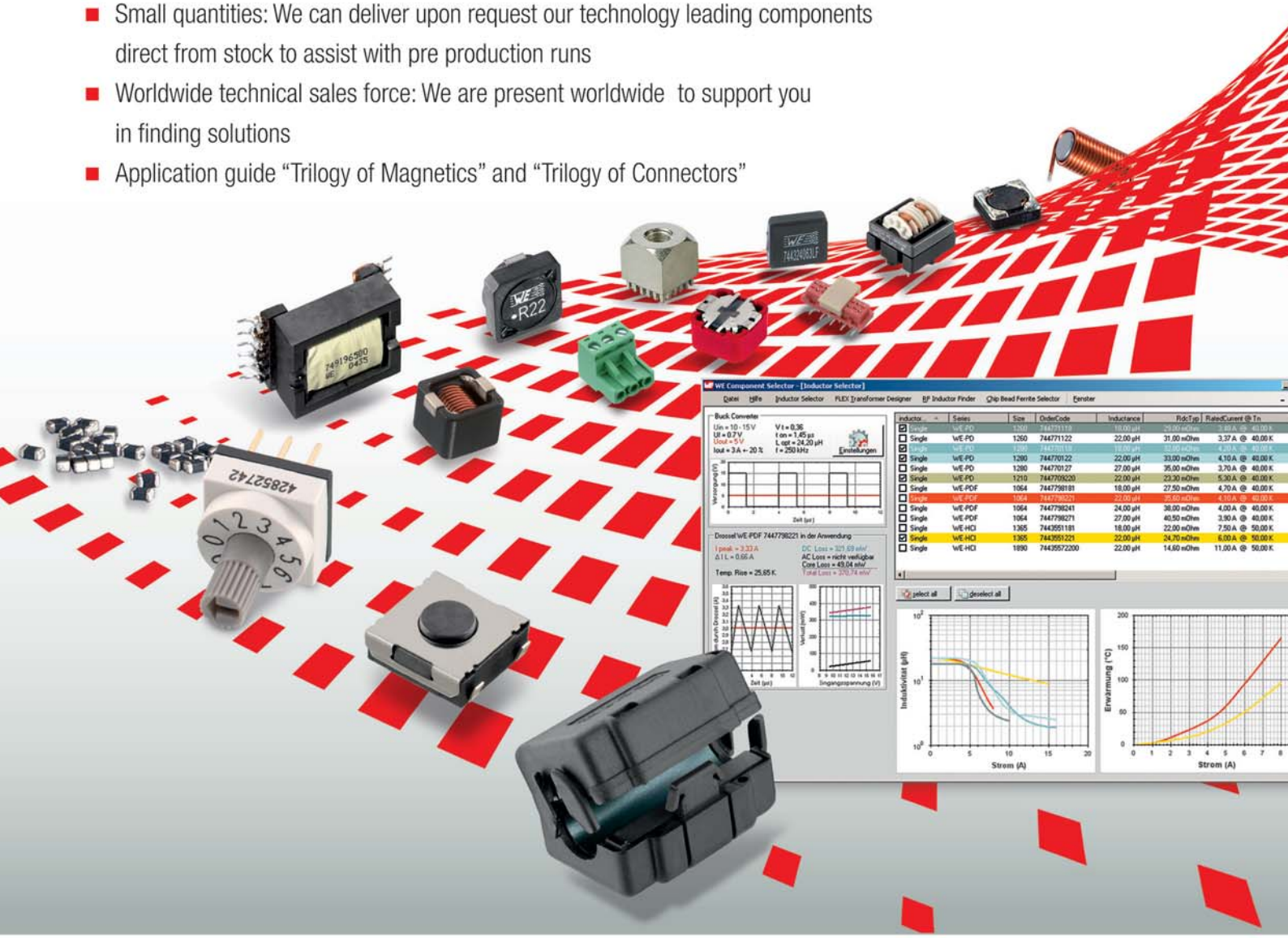


unexplained damage to equipment on his nickel production line.

On each occasion the equipment damage was confined to a 690V system that was being fed by a 3.15MVA transformer at OMG Harjavalta Nickel Oy's production plant in Finland. Over 2MW of the load on this system is controlled by frequency converters and Sihvonen had his suspicions that the culprit could be these non-linear loads and variations they were producing in the network power quality.

Sihvonen, OMG's electrical and automation manager, is not the first end user to experience the potentially damaging effects of non-linear loads on a power network.

End users and power companies are increasingly concerned about the phenomenon of harmonics. Harmonic distortion can manifest itself in some serious ways and may disturb or even damage sensitive equipment connected to the same electrical network.

You may not be able to see, smell or hear a harmonic but you can detect its damage by way of excessive heating of conductors, motors or transformers through to spurious tripping of circuit breakers, damage to lighting and interference with communications equipment and even mechanical vibration.

Non-linear loads connected to the network, such as rectifiers and regular motor drives, produce harmonic components in the network current and, via the current in, result in a distorted network voltage.

(Taken from "Using frequency converters to control harmful harmonics", by ABB, www.connectingindustry.com/story.asp?storycode=186878, 23 Sep 2008)

661 Nuclear power plant RF transmitter exclusion zones don't work

However, exclusion zones have in some cases failed to provide the required protection and are becoming increasingly burdensome to establish and enforce. This was the consensus, lead by one lead I&C engineer from a major US utility in the south who is currently designing advanced nuclear plants (with one under construction) at the December 2008 EPRI Nuclear EMI Working Group Meeting held in Washington, DC.

Interference incidents which have occurred give evidence to the failure of the exclusion zone strategy to provide the desired level of EMC protection for I&C systems in existing nuclear plants. There are many documented cases of malfunction and upset of I&C systems in existing plants caused by operation of a portable wireless transmission device (not always a walkie-talkie) too close to a standard system cabinet with its doors closed.

At times, the failure is caused by a source of EM energy that was not recognized as such where an exclusion zone was not involved. One example occurred when the starter for a high intensity discharge (HID) lighting system (magnetically-ballasted) emitted an EM pulse when it attempted to strike a burned out lamp. Because the lamp was burned out, the starter repeatedly attempted to ignite it, emitting a continuing stream of EM pulses as a result. These emissions caused false detections to be registered in a radiation monitor located in another room in the plant. Radiated EM pulses from failed lamps were converted into a band of conducted emissions coupled into the signal loop of the radiation monitoring system. This caused frequent false alarms in the control room.

Another reason for the failure of exclusion zones is that with the increasing use of wireless technology, enforcement of exclusion zones is increasingly problematic. As wireless technologies are adopted and become a more significant part of the work equipment for various personnel, like maintenance workers and security personnel, conflicts are created when enforcement of the exclusion zone would deprive a worker of the tools they rely on to perform their job. This kind of conflict is likely to become increasingly prevalent as wireless technologies are used for an ever increasing variety of functions. Moreover, in today's culture of increased security required to protect nuclear plants and instantly respond to any potential threat, security and plant personnel, any restriction on the use of portable wireless devices will only limit the effectiveness of these personnel to protect the staff and the plant from a possible catastrophic situation. Security personnel must be focused on protecting the plant and staff without having to worry about tripping a critical safety-related I&C system.

The job of an I&C engineer and other plant personnel on the plant floor frequently involves the use of portable wireless devices when the doors of system cabinets are open. Communications are needed with other personnel out in the plant to maintain and troubleshoot I&C systems. Without these communications, standard procedures needed to bring I&C systems back up on line could not be performed.

(Taken from: "Eliminating the need for exclusion zones in nuclear power plants", by Philip F. Keebler, Electric Power Research Institute, In Compliance magazine, June 2011, www.incompliancemag.com/index.php?option=com_content&view=article&id=699:eliminatingthe-need-for-exclusion-zones-in-nuclear-power-plants&catid=26:design&Itemid=130.)

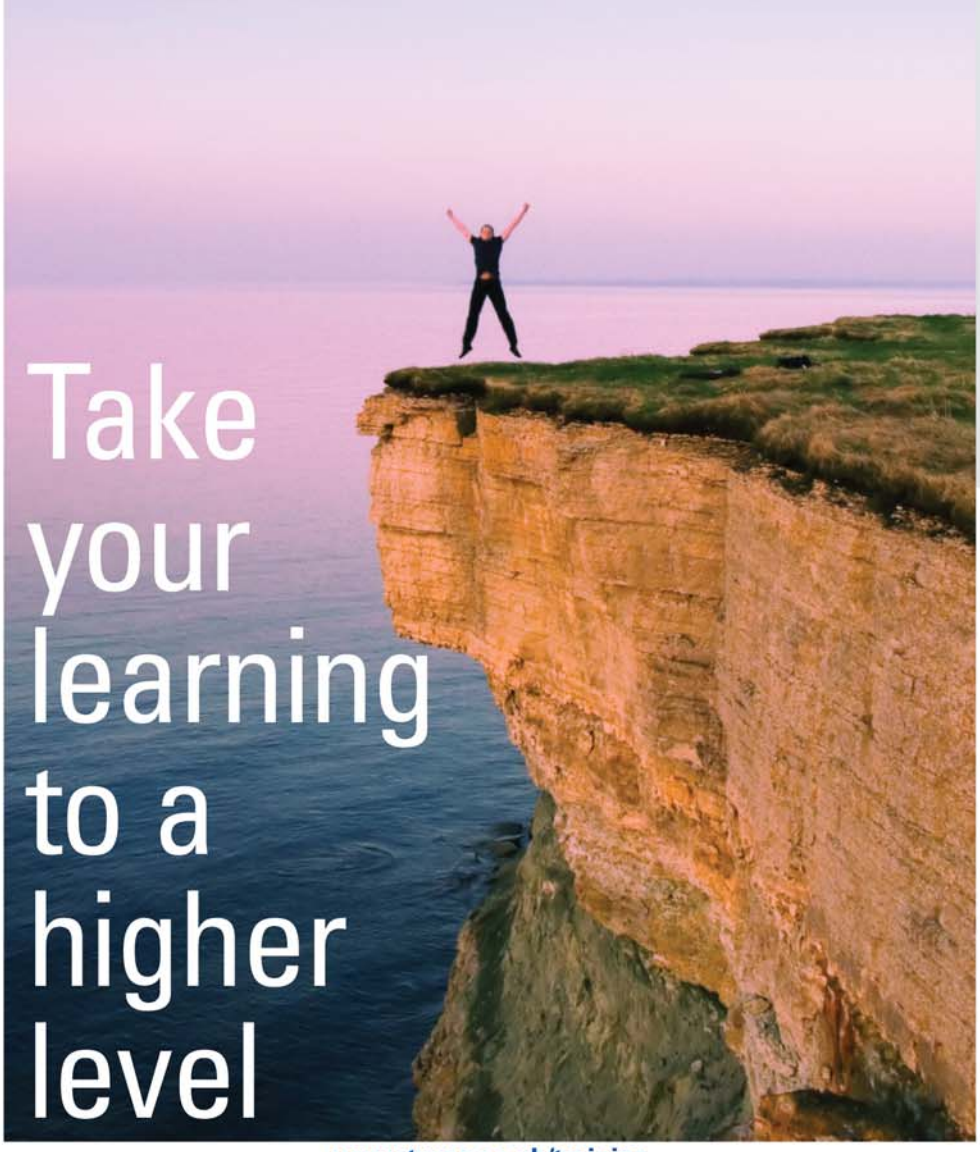
662 Cool Facts about Lightning

Lightning is essentially a gigantic electrical spark that results from billions of volts of natural static electricity. Lightning is usually associated with thunderstorms and rain. Most meteorologists will agree that ice formation in clouds is a key factor for starting the "electric generator" that produces lightning. There are several theories as to how lightning is produced. It seems the best one so far [called the "Charge Reversal Concept"] requires that falling graupel (small ice pellets) become negatively charged while small supercooled cloud droplets that strike then bounce off the graupel become positively charged. Cloud temperature can affect the "charge sign" of the graupel. If the temperature is below -10C then the graupel takes a negative charge and the supercooled cloud droplets take a positive charge. The supercooled cloud droplets rise on updrafts to the top of the storm while the graupel pellets fall and melt in the lower regions of the storm.

Lightning Safety Facts from NOAA:

- Each second there are 50 to 100 Cloud-to-Ground Lightning Strikes to the Earth world-wide.
- Most lightning strikes average 2 to 3 miles long and carry a current of 10,000 Amps at 100 million Volts.
- A "Positive Giant" is a lightning strike that hits the ground up to 20 miles away from the storm. Because it seems to strike from a clear sky it is known as "A Bolt From The Blue". These "Positive Giant" flashes strike between the storm's top "anvil" and the Earth and carry several times the destructive energy of a "regular" lightning strike.
- Thunder can only be heard about 12 miles away under good quiet outdoor conditions.
- Daytime lightning is difficult or impossible to see under local sun and/or hazy conditions. Night-time "heat lightning" can be seen up to 100 miles away (depending on "seeing" conditions).
- "Lightning Crawlers" or "Spider

Continued on page 14



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Lightning" can travel over 35 miles as it "crawls" across the bottoms or through squall line "frontal" clouds. This rare type of lightning is very beautiful as it zaps from "horizon-to-horizon". However it can turn deadly if it happens to strike the ground at the end of its super long path! {Lightning Crawlers from The Blue!}

- Radar has detected Lightning "Crawlers" traveling at high altitudes (15,000 ft to 20,000 ft) as they zap from cloud-to-cloud.
- Lightning "Crawlers" over seventy five (75) miles long have been observed by Radar!
- The temperature of a typical lightning bolt is 5x hotter than the surface of the Sun!
- How big around is a typical lightning bolt? Answer: About the size of a Quarter to Half-Dollar! Lightning looks so much wider than it really is just because its light is so bright!
- Lightning Strikes create powerful radio waves in the frequency range of 3 kHz (audio, VLF) through 10 MHz (shortwave radio). The VLF (3 kHz to 30 MHz) "lightning signatures" can travel around the world, allowing monitoring of world-wide lightning. The shortwave "lightning signatures can travel half-way around the Earth (the night-time side of the Earth). The best region to listen for distant shortwave lightning signatures is from 2 MHz through 7 MHz. After 3 AM local time you can listen to 3 MHz and hear the beautiful dispersion-ringing of the static as it bounces back-and-forth between the earth and ionosphere. It can at times sound like hundreds of tiny bells ringing at once!
- Red Sprite lightning is a newly-discovered type of lightning that zaps between the 40 mile span between the tops of severe storm clouds to the lower ionosphere "D" layer. Red Sprite Lightning looks like a giant "blood-red"-colored jellyfish having light-blue tentacles. Red Sprite Lightning creates extremely powerful radio emissions from 1 kHz through VHF.
- Red Sprite Lightning has been associated with very powerful "Atmospheric Gamma Ray Bursts". Nuclear Radiation from Lightning Strikes!

(Taken from "Cool Facts" by Nextek, www.nexteklightning.com/enews/408/coolfacts.htm 23 May 2008)

663 Opamps with inherent RF immunity

The experiment is performed on two different dual op amps: a typical standard op amp and the LMV832, EMI hardened dual op amp. A cell phone is placed on a fixed position a couple of centimetres from the op amps in the sensor circuit.

When the cell phone is called, the PCB and wiring connected to the op amps receive the RF signal. Subsequently, the op amps detect the RF voltages and current that end up at their pins. The resulting effect on the output of the second op amp is shown in Figure 6.

The difference between the two types of dual op amps is clearly visible. The typical standard dual op amp has an output shift (disturbed signal) larger than 1V as a result of the RF signal transmitted by the cell phone. The LMV832, EMI hardened op amp does not show any significant disturbances. This means that the RF signal will not disturb the signal entering the ADC when using the LMV832.

(Taken from the LMV831 preliminary datasheet dated August 5, 2008, available from www.national.com.)

664 Even the tiniest track of the most carefully designed printed circuit board (PCB) behaves like a microwave transmission line

The growth of electronics, the use of higher frequencies, and the omnipresence of fast computing devices have made electromagnetic compatibility (EMC) a global concern. With electronics working at speeds of a few hundred megahertz to some gigahertz, even the tiniest track of the most carefully designed printed circuit board (PCB) behaves like a microwave transmission line. Previously, increasing working frequencies extrapolated electromagnetic inter-ference (EMI) problems from long power lines to smaller PCB tracks, and history is repeating itself by moving this issue toward the field of microelectronic circuits. Due to their small size, integrated circuits (ICs) are, in practice, not easily disturbed by radiated disturbances; they are, however, prone to noisy conducted interference.

(Taken from the Introduction section of "An externally trimmed integrated DC current regulator insensitive to conducted EMI" by Jean-Michel Redouté et al, IEEE Trans. EMC, Vol. 50, No. 1, February 2008, page 63.)

665 Kangaroo leather shoes increase ESD from 5kV to 15kV

Dan Hoolihan has been practicing in the EMC arena for more than three decades. The following story falls into the 'strange but true' category that experienced EMC engineers, such as Dan, always have a number of in their files. How would users react today with these kind of operational instructions?

"Back in the 1970s when electrostatic discharge (ESD) and its impact on electronic equipment was first being researched, many companies were experimenting with various ways to test equipment for ESD susceptibility. Since "standard" ESD generators were not available, many companies developed their own generators including small Van de Graaff machines, lab-built generators, and standard nylon carpets.

A low-cost computer terminal (an electronic station designed to allow a person to communicate with a large, highspeed mainframe) was developed by a computer company in the United States. The terminal was successfully designed, tested for conformance to internal corporate specifications, and went into production. The design verification testing included both emission and immunity testing for EMC performance. One of the immunity tests was an ESD test using a "standard" nylon carpet that the tester would shuffle his feet on and measure about 5 kilo volts (with a sensitive electrostatic voltmeter) before discharging himself to the unit under test. The terminal passed the test and was used successfully around the world except in Australia.

In Australia, the terminal had consistent ESD failures. In attempting to trouble-shoot the problem, an engineer from Australia came to the United States and worked with the design engineers. The computer terminal was placed in a large environmental chamber and the relative humidity was lowered to about 10% for a worst-case test of ESD. The engineer from Australia stepped on the "standard" nylon carpet, shuffled his feet and the electrostatic voltmeter measured 15 kilovolts instead of the usual 5 kilovolts, and, of course, when he discharged to the terminal, it failed.

The design engineers were amazed at the amplitude of the voltage and started to quiz the Australian on what he was doing or what clothes he was wearing. He convinced the design engineers he had on "normal" clothing except for his kangaroo leather shoes!

The company had a choice of coming up with a special fix for the product for Australia or outlawing kangaroo leather shoes. They chose to recommend to their Australian customers to preclude the

Continued on page 16

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wearing of kangaroo leather shoes if they wanted to avoid ESD problems with the low-cost terminal."

(Taken from "Chapter Chatter – Special ESD Test from Down Under", by Todd Robinson, Associate Editor, IEEE EMC Society Newsletter, Issue 216 "Winter 2008", April 2008, page 10, www.emcs.org/acstrial/newsletters/winter08/chatter.pdf)

666 Timely EMC fix on a satellite helped a lifetime's career

The knowledge of having an EMC background can help all of you; in particular, what I am going to talk about is how it helped me in my career. When I first began my career back in 1951, for the first few years all I did was make EMC measurements. And then, one day, my boss quit for greener pastures and there was just a younger engineer and myself there at a large engineering design and development organization. I really knew nothing about EMC principles. I knew about measurements, but I didn't know about principles. I had joined the IRE at the time as a student in college. I became active in the IRE and I looked to those people to help me gain knowledge in EMC. I was really helped. It was very challenging to me. It was invigorating and frustrating, but I learned many things.

After I learned, a company in Massachusetts made me an offer I couldn't refuse. So I left RCA and went to Massachusetts. I was there for a while and since it was not my cup of tea, I left. I eventually came back to RCA at the RCA Space Center in Hightstown, New Jersey. It was called the RCA Astro-Electronic Division. They didn't pay any attention to EMC, and I didn't work as an EMC engineer. I had gotten out of EMC, but I was sucked back in by an event that changed my career, and really helped me.

I was working as a Reliability Engineer on a weather satellite for about three years. At that time, the weather satellites were relatively simple. Later generations were designed to give you the five-day weather forecast, but in those days they primarily were built to give hurricane warnings. But they kept on being improved to give you more and more data. Anyway, they built this weather satellite for the U.S. Air Force, but before they could ship the satellite, it had to pass ground simulation tests. Now, you have to understand that the way these satellites work, when it is overhead, what it does is it transmits the data directly to the Earth. But when it goes over the horizon, at that point the data is put on a tape recorder and the tape recorder then feeds it to a transmitter that transmits it to the next ground station. During these final simulation tests, they turned on both the transmitter and the tape recorder. The transmitter, low and behold, kills the tape recorder. Nothing intelligible came out of the tape recorder. There was a panic because that satellite had to be shipped in several weeks. If they didn't ship it, there would be a lot of penalties monetarily and they might lose their turn on the launching pad. So, they had a team of managers, including the Chief Engineer of the Division, trying to solve the problem. But they weren't using EMC principles. They kept turning the antenna of the transmitter around and kept trying to operate the tape recorder in a different way. None of these things worked. Then, someone remembered that several years ago I had worked in EMC. I was told to put a "bunny-suit" on and go in the clean area and see what I could do about this satellite. Of course, they didn't pay any attention to me at the time because I was just an engineer, and they were all high level managers. So after they got tired they all walked out. There was one manager there, the manager of the design review team (because at RCA Astro, before you could release a design for space it had to undergo a design review process). He asked me, "Can you really solve this problem?"

I said, "Gee...I haven't done this work for three years so I don't know whether or not I can solve it. But if you want me to try, I need several things. First of all, I need priority in purchasing. I don't want to go through any red tape to buy anything I need. Second, I need priority in the model shop; I want to be able to build a fixture over night and try it right away. Third, I need a mechanical engineer assigned to me so that whatever we come up with we can implement as a final design. He said, "You got it."

This tape recorder was actually a sealed unit because it had to be vacuum protected. That made it easy for me. We couldn't change the tape recorder, so, what we did is we designed an add-on box. This add-on box had three compartments; one compartment was for signal wires separated from the other two compartments. The second compartment was for command and control wires. The third compartment was for power signals. Each of the compartmental wires had to go through a bulkhead that was within this add-on unit. There were filters mounted on the bulkhead and the filters were of different strength depending on whether it was a signal wire, or a command and control wire, or a power wire. Then the big day came. We turned on both the tape recorder and the data transmitter and it worked (readable data was coming from the tape recorder). Somebody said, "Oh, I bet someone forgot to turn the transmitter on." The transmitter was turned on...and it worked.

Following that, I became the go-to guy. Whenever there was an EMC problem they came to me. Whenever there was a proposal, they put my name in the proposal. I came up with a set of ground rules for EMC principles that the division had to follow. I got the blessing of the chief engineer that they had to be followed. Twenty years later, when I left RCA to retire, they were still following those EMC principles. This really helped me because several weeks after this event I went back to work as a Reliability Engineer; that was my job. Two weeks later I got a commendation letter. Several months later I got a call from the chief engineer's office. I was invited to a dinner and I was to bring my wife. I was presented with an engineering excellence achievement award.

This helped me in other ways. There was a brutal layoff later on and since I had received this engineering excellence award they couldn't lay me off, so I survived. What happened later on, I believe happened because of the recognition I received from this event. I became a group manager where I had responsibility for parts engineering, both passive parts and active parts, and for materials engineering. I was also responsible for reliability analyses and predictions, and for the failure analysis lab. And, yes, last but not least I was also responsible for EMC.

(Taken from "EMC War Story – by EMC Society Founder Vincent Mancino", in the IEEE EMC Society Newsletter, Issue 216, "Winter 2008", April 2008, page 60, www.emcs.org/acstrial/newsletters/winter08/war_story.html)

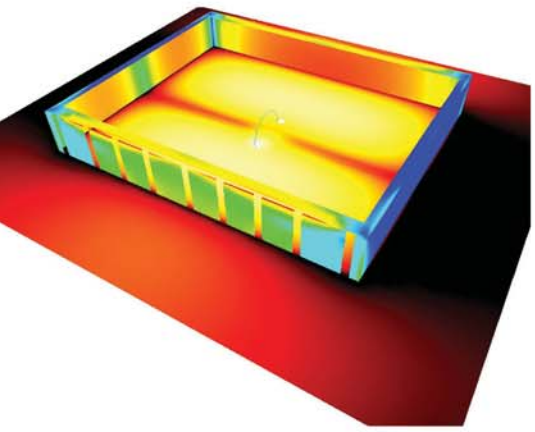
Banana Skins

Banana Skins are kindly compiled for us by Keith Armstrong.

If you have any interesting contributions that you would like included please send them, together with the source of the information to: keith.armstrong@cherryclough.com

Although we use a rather light hearted approach to draw attention to the column this in no way is intended to trivialise the subject. Malfunctions due to incorrect EMC procedures could be life threatening.

Explore the EM simulation universe



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CHANGING THE STANDARDS

John Woodgate's Column

PLT milestone (or is it millstone?)

The British Standards committee had to vote on the final draft of EN 50561-1 - the standard that 'lets PLT get away with it', on 25 August. Apart from many comments from the bodies represented on the Committee, some twenty four industry bodies, firms and private individuals submitted comments, and some of them were insightful:

1. Short-wave broadcasting is an important social and political asset; it cannot be totally blocked by oppressive regimes;
2. The noise level in the proposed band is too high, leading to a power requirement that produces significant emissions from the poorly-balance mains wiring;
3. Dynamic notching has not been proved in the field;
4. The proposed test methods do not represent real operating conditions;
5. The emissions may travel long distances due to ionospheric propagation;
6. HF communication is vital for civil aviation and defence purposes;
7. Existing PLT installations affect FM and DAB radio reception;
8. Electronic Article Surveillance and Radio Frequency Identification systems will suffer interference;
9. It should be recognised that the standards process cannot resolve the issue;
10. There is no need for a special standard; according to its scope, EN 55022 applies;
11. VDSL-2 services have already been compromised by PLT emissions;
12. The standard is technically inadequate even for regulatory control, and protection of radio services has clearly been abandoned;
13. The standard will reduce the already very small number of interference complaints;
14. The low-VHF band is not suitable as it is to be used for high-speed data communication systems;
15. Non-linear loads on the mains network create intermodulation products that are likely to defeat mitigation measures such as notching;
16. BSI has a special responsibility to society;
17. The standard is 'technically immoral' and inconsistent with other related standards;
18. No market surveillance or enforcement action against products in use is likely to succeed, because it can be claimed that EN 55022 does not apply specifically to PLT. The new standard would allow legal actions to succeed;
19. Immunity levels of a wide range of equipment would need to be substantially improved in order to cope with the emissions permitted by the proposed standard;
20. If the standard is rejected, the European Commission will impose regulations based on it;
21. BSI is urged to arrive at a consensus position and not abstain from voting.

It may come as no surprise that the BSI committee could not agree, and is therefore bound by BSI rules to enter an abstention.

Radiated emission limits below 30 MHz

As a result of reports from some National Committees, CISPR circulated a questionnaire on the need for radiated emission standards in the frequency range below 30 MHz; conducted emission standards already exist. In the past, emission standards have not been seen to be necessary, as most equipment is too small, even including cables, to radiate (too) efficiently at such frequencies.

The questionnaire posed three questions which can be summarised as:

1. Do we need limits?
2. Have you found interference cases?
3. Should limits apply to all products or only those expected to produce significant emissions in this frequency range?

The voting results are a bit unexpected, but the work will go ahead, requirements being confined to products expected to produce significant emissions. The British committee, along with several others, did not see any need, and the US and Germany abstained (maybe because of conflicting opinions, although the German National Committee gave such a detailed response that a clear vote could not be extracted).

The Austrian National Committee called attention to the history; conducted emission limits were derived from consideration of radiated emission levels, but the latter no longer appear in standards. Existing emission limits in this frequency range address only the magnetic field, but potential victim equipment may be more sensitive to the electric field, and at practicable measuring distances there is no correlation between electric and magnetic field strengths in this frequency range.

Sources of such radiated disturbances are reported to be plasma TV receivers and electric vehicles (trams and lifts). Several National Committees expect that cases of interference will increase. Others maintain that because they haven't had any cases reported so far, there is no need for any work on the subject. Maybe the IEC should introduce an Ostrich Award.

Unexpected safety issue

You would not expect a USB 'memory stick' to be involved in a fatal accident, but it happened when someone swallowed an end-cap and it lodged in a crucial position in the airway. Ball-point pen caps have had one or more holes in order to prevent them causing asphyxiation, but, because of the shape of the USB cap, holes would not have worked. Designs exist where the cap is attached by two springy and very strong wires, so it can be retracted and swung to the side to allow the connectors to engage. Another design has a retractable connector, so there is no separate cap at all.

There is no product standard for USB devices (as opposed to the proprietary protocol for the interface itself), as is the case for almost all ITE products, but the appropriate safety standard appears to be IEC/EN 60950-1 (at least, until IEC 62368-1 is finally sorted out, if ever). Unfortunately, even the applicability

of IEC/EN 60950-1 is allegedly debatable, due to the wording of the Scope clause. The first line reads:

> This standard is applicable to mains-powered or battery-powered information technology equipment,...

A USB stick in use IS either mains- or battery-powered, albeit not directly, but the standard does not say 'directly'. Nevertheless, some people do not agree: perhaps they think it is powered by magic!

There is a body of opinion, however, in the British committee that holds that IEC TC108 would be reluctant to add a new safety requirement to IEC 60950-1, or even to IEC 62368-1. It is difficult to support that argument, in the context of a fatal accident.

Unexpected safety issue 2

This one is of an quite different nature - a case of a test house 'gold-plating' IEC/EN 60065. The still controversial requirements in EN 55032-2 controlling sound levels from headphones are clearly restricted to portable battery-operated products, but a test house in Asia insisted on applying the standard to a mains-operated DVD player. There ought not to be ANY doubt about this. The title of the standard is 'Headphones and earphones associated with ***portable audio equipment***, and the Scope clause quite clearly says 'battery-operated'.

If the test house were in Europe, it would be fairly easy to bring pressure to mend its ways, but in Asia it is much more difficult. Maybe only loss of business would have an effect.

New OJ list of safety standards

A new list of approved safety standards was published on 30 August 2011. It can be seen here:

> http://ec.europa.eu/enterprise/policies/european-standards/documents/harmonised-standards-legislation/list-references/low-voltage/index_en.htm

The latest list of EMC standards is dated 21 February 2011, so a new list *might* be issued soon,. It can be found at:

> http://ec.europa.eu/enterprise/policies/european-standards/documents/harmonised-standards-legislation/list-references/electromagnetic-compatibility/index_en.htm

However, these lists are *derived from* the Official Journal, so may not always be up to date. It is possible, but much more difficult, to find the relevant, definitive 'C sections' of the OJ, at:

> http://eur-lex.europa.eu/JOYear.do?year=2011

because the search engine is very limited.

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Know Your Standards

Saga

Since this is an on-going series, I recommend that you look at previous offerings, because each one provides a background for its successors and thus helps understanding.

Last time we looked at different types of 'standards publication'. It was suggested that a table to summarize would be useful, so here it is. It is based on the way IEC identifies types, because that is the most 'structured' way. Rather than the cumbersome 'standards publication'. it is convenient to use 'standard' to mean any of these except Guide, and use 'Standard' when we mean only a fully normative publication.

Type of publication	Abbreviation	Description
Standard	none	'Normative' (i.e. prescriptive) document; uses 'shall' for provisions
Technical Report	TR	Review, survey or generally descriptive document; uses 'should' for recommendations
Technical Specification	TS	A possible future standard or a normative document which has strong support but no consensus for publication as a standard; uses 'shall'
Publicly-available Specification	PAS	Normative document obtained from another body that may become an IEC standard after experience of its use has been gained; uses 'shall'
Guide	none	One of a separate series of documents, addressed to standards committees rather than standards users. Some Guides are normative, or have parts that are normative.
Test Report Form	TRF	Guess? These official forms are not mandatory, but impress clients. They can be quite costly

There is another classification system that helps to understand the relationships between standards that deal with the same product type.

Class	Description
Product standard	Deals with the characteristics of the product as they affect its application. May include methods of measurement or performance requirements, or both (then it must be a Standard)
Methods of measurement Standard	Deals only (or almost only) with methods of measurement
Performance Standard	Deals with performance from the user's point of view
'Regulatory' performance Standard	EMC Standard or Safety Standard

Even that is not the end of the story, because 'regulatory' standards have a classification of their own, but implemented differently in safety and EMC standards!

Type	Description of safety Standard	Description of EMC Standard
Generic	Gives requirements that are applicable to products that do not have an applicable product family or product standard and set a benchmark for the requirements specified in those standards Usually Part 1 of a multi-part standard; includes methods of measurement	Gives requirements that are applicable to products that do not have an applicable product family or product standard and sets a benchmark for the corresponding requirements specified in those standards A Standard in the IEC 61000-6- series
Basic	Rare; an example is IEC 60990 on measurement of touch current. Often about methods of measurement.	Gives methods of measurement that are applicable to most product families; suggests numerical requirements based on those methods Standards in the IEC 61000-4- series and the CISPR 16 series
Product Family	Deals with a range of products using **closely** similar technology; usually a Part other than Part 1, or a section of Part 2, of a multi-part standard. May include additional methods of measurement	Deals with a range of products using **broadly** similar technology (maybe **very** broad, e.g. IEC 61000-3-2 and -3 cover almost all mains-powered products) Standards in the IEC 61000-3- series and CISPR NN-n standards, except the CISPR 16 series, also some standards produced by product committees.
Product	Deals with a closely-defined product; usually a section of Part 2 of a multi-part standard	Some standards produced by product committees
Support	A TR or TS that gives guidance and recommendations where a Standard does not exist	A TR or TS that gives guidance and recommendations where a Standard does not exist

Generic safety Standards

There are too many of these to list, but notable ones include IEC 60065 (consumer electronics), IEC 60204-1 (machinery), IEC 60335-1 (household appliances), IEC 60601-1 (medical), IEC 60950-1 (ITE and office machines) and IEC 61010-1 (measuring instruments, industrial process control and laboratory equipment).

There are EN versions of all of these, with varying degrees of difference from the IEC version. Since even a small difference may affect YOUR product profoundly, it is most unwise to consult the IEC when the EN applies, or vice versa.

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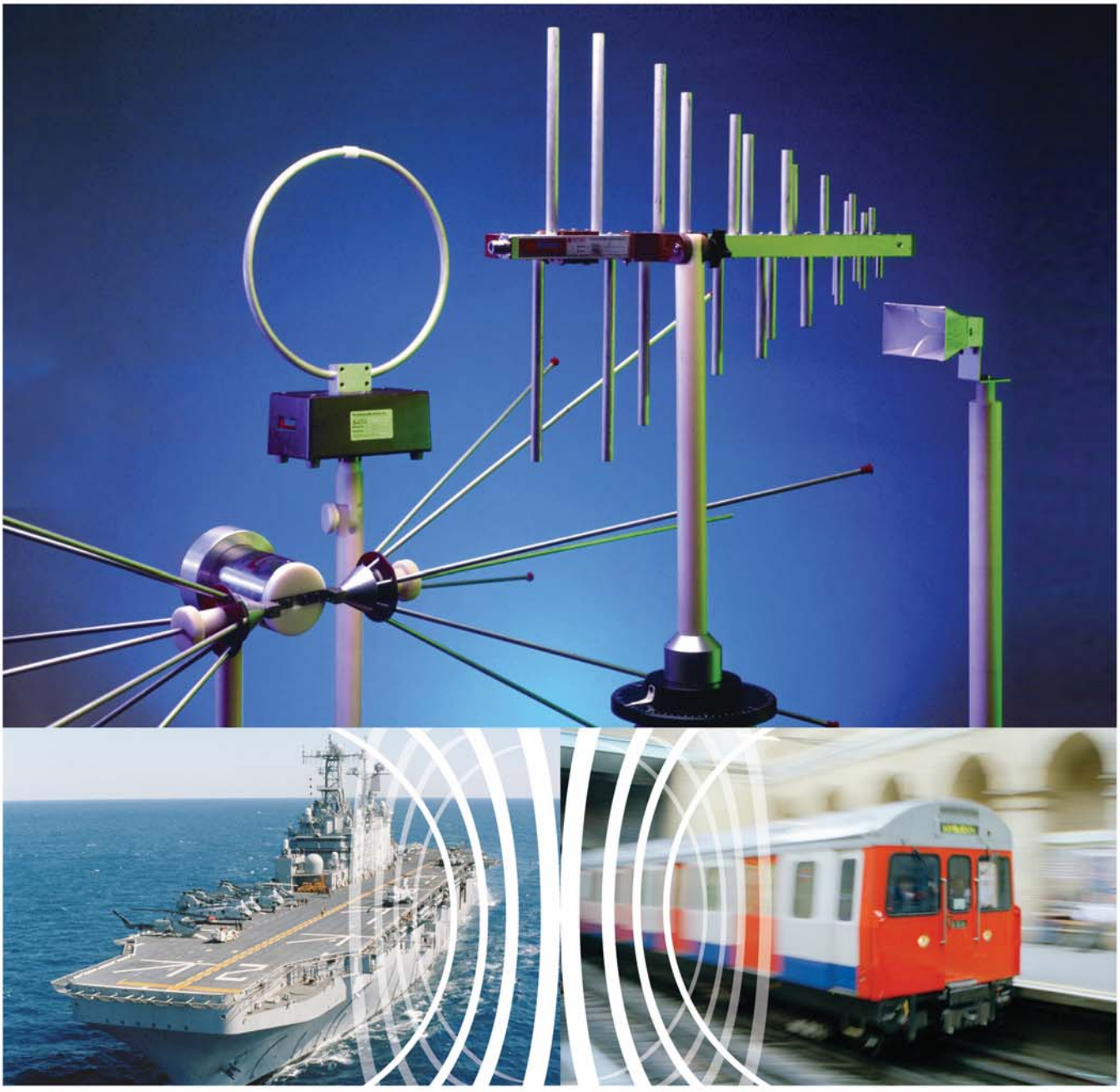

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Generic EMC standards

Reference	Property	EMC environment
IEC 61000-6-1	Immunity	Residential, commercial and light industry
IEC 61000-6-2	Immunity	(Heavy) Industrial
IEC 61000-6-3	Emission	Residential, commercial and light industry
IEC 61000-6-4	Emission	(Heavy) Industrial
IEC TS 61000-6-5	Immunity	Power station and sub-station

Basic safety Standards

There are few of these with wide application, except IEC 60990, already mentioned above.

Note - the terms 'basic safety Standard' and 'basic safety publication' are not of the same meaning.

Basic EMC Standards

Reference	Description
IEC 61000-4-1	Overview of the IEC 61000-4 series
IEC 61000-4-2	Immunity to electrostatic discharge (ESD)
IEC 61000-4-3	Immunity to radiated radio-frequency electromagnetic fields
IEC 61000-4-4	Immunity to fast transients or bursts
IEC 61000-4-5	Immunity to surges
IEC 61000-4-6	Immunity to conducted disturbances induced by radio-frequency fields
IEC 61000-4-7	Measurement of harmonics and interharmonics of the power supply
IEC 61000-4-8	Immunity to power frequency magnetic field
IEC 61000-4-9	Immunity to pulse magnetic field
IEC 61000-4-10	Immunity to damped oscillatory magnetic field
IEC 61000-4-11	Immunity to voltage dips, short interruptions and voltage variations
IEC 61000-4-12	Immunity to ring-wave
IEC 61000-4-13	Immunity of the AC power port to harmonics, interharmonics and low-frequency mains signalling
IEC 61000-4-14	Immunity to voltage fluctuations
IEC 61000-4-15	Flickermeter specification
IEC 61000-4-16	Immunity to conducted common-mode disturbances, 0 Hz to 150 kHz
IEC 61000-4-17	Immunity to ripple on DC input power port
IEC 61000-4-18	Immunity to damped oscillatory wave
IEC 61000-4-19	Not issued
IEC 61000-4-20	Emission and immunity testing in transverse electromagnetic (TEM) waveguides
IEC 61000-4-21	Reverberation chamber test methods
IEC 61000-4-22	Not issued
IEC 61000-4-23	Test methods for protective devices for HEMP and other radiated disturbances
IEC 61000-4-24	Test methods for protective devices for HEMP conducted disturbance
IEC 61000-4-25	Immunity to HEMP for equipment and systems
IEC 61000-4-26	Not issued
IEC 61000-4-27	Immunity to unbalance [of 3-phase power supplies]
IEC 61000-4-28	Immunity to variation of power frequency
IEC 61000-4-29	Immunity of the DC power port to voltage dips, short interruptions and voltage variations
IEC 61000-4-30	Measurement of power quality
IEC 61000-4-31	Not issued
IEC 61000-4-32	High altitude electromagnetic pulse (HEMP) simulator compendium
IEC 61000-4-33	Measurement methods for high-power transient parameters
IEC 61000-4-34	Immunity of equipment with input current more than 16 A per phase to voltage dips, short interruptions and voltage variations

The above descriptions are not necessarily the titles of the standards, some of which murder the English language. The French titles are, of course, much more grammatical. The 'not issued' standards exist as titles on an IEC TC77 internal master list but may never be developed and published.

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Know Your Standards

by J.M. Woodgate B.Sc.(Eng) C.Eng. MIET MIEEE FAES FInstSCE

This is the 4th in the Know Your Standards series and we have collected all the submissions into one portfolio on our website:

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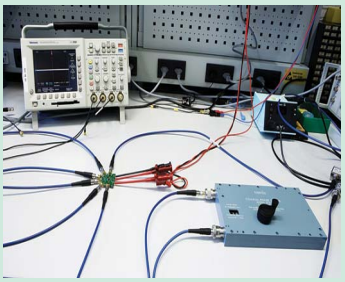
PRODUCT GALLERY

Connector products for T&M applications as well as screened & shielded types featured by FC Lane at EMCUK

Connectors on show from Weald, HUBER+SUHNER & Polamco



FC Lane Electronics, one of the UK's leading electrical and electronic connector specialists, is exhibiting at EMCUK 2011, the only exhibition dedicated to the all-important subject of EMC, which is again being held at Newbury Racecourse Exhibition Centre from 11 to 12 October.

According to Managing Director Simon Hammerton, FC Lane will bring together connectors and connector systems for test and measurement applications as well as those designed to combat the effects of EMC and EMI.

Earlier this year, Lane became a global E.Commerce partner with HUBER+SUHNER for its comprehensive range of connector products for all types of test and measurement applications. As a result, Lane Electronics is now holding significant stock levels of HUBER+SUHNER's test leads, adaptors, terminations, attenuators and test kits – available the following day to anyone who visits HUBER+SUHNER's website – www.hubersuhner.com Members of Lane's product applications team will be available at the show to discuss how HUBER+SUHNER's connectivity products can help in all manner of T&M situations.

As well as HUBER+SUHNER's T&M products FC Lane will also be showing EMI filtered connectors from Weald Electronics and Backshells for EMI/RFI screened applications from Polamco.

Lane is an ideal source for all key connector types including circular, filtered, RF, coaxial, sub – miniature, backshells and adaptors, D connectors, aerospace, test & measurement, IDC, PCB connectors, edge connectors and connectors for rack and panel applications.

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AR's New Dual Band Amplifiers break down old barriers

The hottest news in town is not that we put two amplifiers in a single chassis, but for the first time you can go all the way from 0.8 to 18 GHz with the reliability of solid state.

Our Dual Band Amplifiers can be used for multiple applications because they are linear and extremely load tolerant.

With **AR**'s Dual Band Amplifiers, you have freedom like never before. You pick the power from 5 to 80 watts. You pick the bandwidth from 0.8 to 8.0 GHz, 0.8 to 10.6 GHz or 0.8 to 18 GHz. We put it together for you in one package that costs less, weighs less, and takes less space than two separate amplifiers. If you want to upgrade later, no problem. We make our Dual Band Amplifiers with built-in flexibility for increased power levels because your needs are constantly changing. Shouldn't your amplifiers change too?

For a full listing of our dual band solid-state amplifiers go to: http://www.arww-rfmicro.com/html/ps-dual-band-amplifiers.asp

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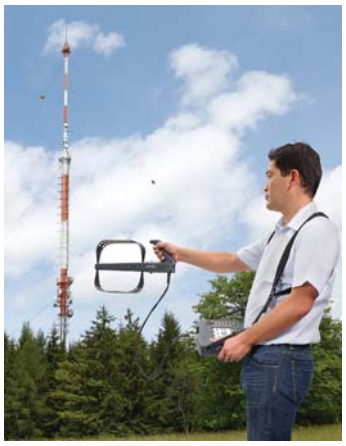
The new IDA-3106 with SmartDF: Localize interference and impairment sources faster and more reliably



Detect, analyze and localize interference and signals: The "Interference and Direction Analyzer" (IDA) from **Narda Test Solutions** solves these tasks in an outdoor-capable device that is also comfortably light in weight at under 3 kg. The new powerful functions and precision directional antennas make direction finding (DF) with the IDA-3106 with SmartDF much faster and more convenient.

Locating interference caused by you or others and identifying potential hazards: Narda Test Solutions combines these applications from the fields of communications and safety in the new "Interference and Direction Analyzer" IDA-3106. IDA can establish the direction of the source independently and display the relative bearing in a polar diagram on the basis of a horizontal scan. The IDA calculates the position of the interference source from several bearing results automatically and displays it. Convenient and practical: Freely available electronic maps can be recorded optionally so that the source can be precisely pinpointed on a street plan, just like a navigation system. Determination of the position of an interference source is based on a GPS receiver in the measuring instrument and the electronic compass in the antenna handle for determining the direction, elevation, and polarization. Extremely light antennas, which can be inserted vertically or horizontally in the ergonomically formed handgrip, are available for different frequency ranges.

As well as these intelligent direction-finding functions (SmartDF), the technical properties of the IDA-3106 are also convincing. An overview of the spectral distribution can be obtained in next to no time at a scan speed of 12 GHz/s. The optional Scope function allows the analysis of even pulsed signals, even the shortest duration signal being detected.

It is also possible to monitor individual carrier signals for an entire day. Real-time data can be recorded to assess the signal quality and bit error rate, for example, and uploaded to a PC for further analysis.

The IDA-3106 is ideal for field applications, thanks to the casing designed for outdoor used, its light weight of under three kilos, hot battery swap without interrupting the measurement, and the user interface that can even be operated comfortably when wearing gloves.

Tel: +49 (0)7121 97 32 777
support@narda-sts.de
www.narda-sts.de

AR Hybrid Power Modules (HPM's) cover 4 – 18 GHz bandwidth with high output power

AR RF/Microwave Instrumentation has introduced a new line of Hybrid Power Modules (HPM's) to its family of solid-state power amplifiers. These HPM's are small, lightweight and compact, yet deliver linear output powers approaching 5 watts across an instantaneous bandwidth of 4 - 18 GHz. They provide excellent gain flatness, can withstand infinite output mismatch, and are available in various power and gain configurations.

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PRODUCT GALLERY

Expanding requirements for Harmonics & Flicker Testing

EM Test, the worldwide leader in conducted immunity and emission EMC equipment and systems, has announcing the release of the first Harmonics and Flicker Test System fully compliant with the standards including the latest editions of the IEC/EN 61000-3-12 Edition 2.0 (2011-05-12) and IEC/EN 61000-4-15 Edition 2.0 (2010-08-24) standards with expanded requirements for harmonics and flicker testing.

"We work closely with the experts and standards committees worldwide to ensure that our customers are ahead of the rest when it comes to being ready for new standards and requirements" says Alain Burger, CTO of EM-Test. "We have developed our Harmonics and Flicker product line, together with the ultra-versatile NetWave AC/DC Power Source, to provide best-in-class performance, flexibility and ease-of-use. For us, it is not enough to excel in one or two of these categories. We always strive to be the best in all three. This is the philosophy that has driven our company and defined our brand for over 20 years."

"For us" continues Alain, "performance is both about the specifications and reliability of the hardware and the powerful tools we provide customers who must develop EMC compliant solutions. Our H&F systems feature AC sources with the lowest source impedance, the highest continuous current ratings and up to 3 seconds of peak current. Our system provides real-time measurement via dual-processor architecture and a multi-tasking kernel, has independent input and simultaneous analysis of voltage and current harmonics and stores every data point on an internal hard disc so that our customers have all of the information necessary to accelerate their development process."

"From a flexibility standpoint, we offer an arbitrary signal generator capable of generating waveforms composed of segments or points to meet any current or future needs including voltage, frequency and harmonics/interharmonics generation under IEC/EN-61000-4-13,14,17,27,28 and 29 . The same equipment can also be used to test in compliance with MIL-STD-704, RT CA/DO-160 and aircraft manufacturer standards with perturbations up to 360 Vrms and 500 VDC. We also offer an extended frequency range from DC to 5 kHz to meet any requirements for testing of higher-order harmonics. We make all of this easy to use with an extensive library of standards and routines and intuitive software driving automated test reports."

"We encourage our customers to read more about our H+F products and the new standards we have implemented, together with our complete product offering on our website, www.emtest.com. We also have service and sales offices worldwide which look forward to helping with any conducted EMC needs."

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AE Techron Power Amplifer now available from AR UK

The 7224 Power Amplifier from AE Techron is a 1 kW Power Amplifier that provides a small-signal bandwidth of DC to 300 kHz. It is capable of 20A at 13.5VDC with a peak pulse potential of 150V or 50A.

The 7224 is the ideal solution for reproducing waveforms required in automotive power quality standards like **Ford CS-2009** (CI230, CI250, CI260), **J1113/2, ISO16750-2, GMW3172,** for driving Helmoltz coils as specified in **J1113/22,** and for aerospace EMC standards like **DO-160** and **MIL-STD-461, CS101,** and **CS109.**

AE Techron, Inc. is a recognised world leader in the design and manufacture of precision industrial amplifiers for the MRI/NMR, EMC testing, Energy/Protection Relay testing and Research Industries.

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PRODUCT GALLERY

Tuned In for Testing

A benchtop tunable filter has just been launched in the UK, aimed specifically at design, development and production test environments for RF and microwave equipment. Manufactured in the US by world-class microwave specialist, **Micro Lambda Wireless**, the MLBF-Series bench top filter is easy to use, efficient and effective in a variety of applications.

Available in the UK from specialist distributor, **Admiral Microwaves**, this compact unit provides engineers in design labs and test environments with a versatile wideband filtering capability, ideal where filtering of microwave signals is essential. Either Bandpass or Bandreject (notch) filter types can be provided, depending on application. Frequency coverage is dependent on which production filter type is chosen.

There are 36 Bandpass models with frequency coverage ranging from 500MHz to 50GHz. Typical

examples include the MLBFP-42026, a 4 stage unit with a 2 to 26.5GHz bandwidth and insertion loss of 7.2dBm. Near the top of the range is the MLBFP-66018, a 6 stage unit with frequency range from 6 to 18GHz featuring insertion loss of 7.2dBm.

In addition, there are 13 Bandreject models covering the 500MHz to 20GHz range. Typical examples include the MLBFR-0204, 10 stage filter with a 2 to 4GHz bandwidth and 2.7dBm insertion loss. Meanwhile, the MLBFR-160818, 16 stage unit offers a frequency range of 8 to 18GHz and insertion loss figure of 2.95dBm.

Each bench top filter assembly consists of a user-selectable YIG-Tuned filter, heat sink, compensated driver, power supply, keyboard, display and cooling fans. Tuning is accomplished via the manual rotary tuning knob, keyboard input, or through the USB or Ethernet interfaces.

In operation, the 2 line x 16 digit display shows the current centre frequency setting on the top display line. Entering a new frequency via the keypad will display on the second line. The new frequency is selected by pressing the MHz key on the keypad.

The instrument can be connected to, and controlled through, a standard PC. Operating systems supported include Windows XP, Windows Vista and Windows 7.

The tunable filter is housed in a compact unit measuring just 25.4 x 10 x 33cm and weighs just 4kg. It is supplied with mounting feet for stable operation and a carry handle for easy portability.

Micro Lambda Wireless offers an extensive range of YIG-tuned filters for use with the MLBF Series. Both Admiral Microwaves and sister company, Aspen Electronics, have specialists on hand to advise customers on selecting accessories, or indeed, specifying equipment for all their RF and Microwave systems and component test and verification needs.

The units are already in production and can be supplied on a 4 to 6 week lead time. Depending on the precise configuration required, the MLBF Series tunable filters cost in the region of £5000.

Tel: +44 (0)1923 859300
sales@admiral-microwaves.co.uk
www.admiral-microwaves.co.uk

Associated Research's Hypot® III family adds new 500 VA Hipot Model

Associated Research, Inc has announced the release of their new Hypot® III model 3780. The 3780 adds a 500 VA (5 kV AC @ 100 mA) Hipot model to the successful line of Hipot testers, which already enjoy a reputation in the industry for their reliability and ease of use. With the addition of the 3780 the Hypot III now provides a reliable, cost-effective, and technologically advanced solution for applications that require 100 mA of AC output current.

In addition to 500 VA Hipot testing functionality, the 3780 also provides a feature set that maximizes test efficiency, while providing a safe and easy-to-use tester. The 3780 offers a simple and easy-to-use graphic LCD for quick test set-up and test recall. The 3780 features an RS-232 interface and can be used as a bench top production line tester or easily integrated into an automated workstation. The 3780 is equipped with the patented SmartGFI® safety feature, which is a high speed shut down circuit that provides maximum operator protection. The 3780 also comes with a remote safety interlock that provides manufacturers the ability to interlock the Hypot III into a test enclosure limiting an operator's exposure to high voltage.

Additional features of Hypot III include:

- Patented VERI-CHEK® feature
- Patented CAL-ALERT® safety feature
- 10 Memories with 3 steps per memory
- Short Circuit current > 200 mA
- Digitally controlled arc detection system
- Built-in adjustable continuity test
- Electronic ramping (up & down)
- Safety Agency Listed

View complete information and specifications at: http://www.asresearch.com/products/hypot3/3780.aspx

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Interference emission from small equipment: A measurement problem brought into focus by the testing of Power Line Adaptors

By Richard Marshall, MA, CEng., FIEE, Finst.P, Richard Marshall Limited

Introduction

A recent Freedom of Information Request has forced the UK regulator Ofcom to publish a position paper [ref.1] to which are appended a number of reports [refs. 2, 3] from reputable test laboratories setting out the results of measurements of the conducted emissions from the data port of Comtrend PG902 modems as supplied with BTVision. These formal reports describe tests made according to EN55022 - ***yet they produce results differing by some 17dB.***

The earliest report [by ERA/RFI ref.2] concluded that the PLAs "do not meet the essential requirements of the EMC Directive", noting amongst other things that the Ethernet data port emission exceeded the Class B limit by 9.6dB. In a commentary by BT also released by Ofcom [ref. 5] it is concluded that the 9.6dB figure "looks invalid" in the light of other measurements made by BT and on their behalf [ref 4].

Reputable test laboratories; a politically-charged situation; wildly divergent results; what is going on? This article offers a technical analysis with implications for several aspects of EMC Standards, particularly as applied to small items with a mains connection and one other interface cable.

The ERA/RFI report

ERA were commissioned by Ofcom to test Comtrend Modems that were supplied with *shielded* RJ45-terminated data cables [ref.2, para.2.1]. To ensure comparability shielded cables were used similarly by the other test laboratories whose reports are referenced here. Since the Comtrend PLAs supplied by BT are boxed with an ***un****shielded* Ethernet cable the original choice is surprising. It is unclear as to how this anomaly arose. Test Lab default policy is to test with the recommended cable type, so the test laboratories concerned cannot be faulted for testing with these cables. ERA did however comment (on page 8 of their report) that the PLAs appeared to make no connection to the cable shield. It is clearly open to anyone wishing to challenge the results to say that they applied to a configuration significantly different to that actually marketed.

ERA subcontracted the actual test work to RFI Global, and included their report [ref. 3] as an annexe to the ERA Report. Neither ERA nor RFI specified or photographed the connection layout, filtering or balance of the mains cable that was applied during the data cable test. It may be that neither of the above test houses, or their clients, realised at that time that it might be as important as is disclosed below.

Blackwood Labs:

The following year Blackwood Laboratories were commissioned by BT to produce an emission report [ref 4] on Comtrend PLAs with very limited objectives. They were to ignore the elephant in the room and just measure the emission from the Ethernet data cable. Blackwood measured conducted emission on the data cable with **un**shielded as well as shielded cables (See their Para.4.1).

The measurement on the **un**shielded cable was made with a Coupling-Decoupling network. The result was a PASS with a margin of 0.7dB. (This has to be taken in the context of a measurement uncertainty U_{CISPR} of 3.6dB according to CISPR-16-4-2.) The report notes the use of an ISN of lesser balance than that specified by the latest edition of the standard: The latter might have yielded an increased pass margin.

The measurement with a shielded data cable showed a PASS with the comfortable margin of 7.2dB on the Average limit. This can be compared with a FAIL from ERA/RFI for a similar EUT configuration with a negative margin of 12.2dB. The two measurements differ by 19.4dB. What caused this?

The termination of the mains cable during the conducted test is unclear from the description and diagram in paras. 2.2. and 2.3, but from photo 1 in Annexe B we can see that the supply was from a LISN. (The LISN is in the background, connected via a short cable to a distribution strip, and thence via a further short cable to the EUT on the table where self-capacitance to ground would be minimal). This is an essentially well-balanced mains supply network with 50 ohms impedance to ground from each wire.

Could the difference between the data cable measurements at the two test laboratories be accounted for by the different mains cable set-up?

Technical Analysis:

A Power Line Telecommunications Adaptor has just one "mains" dual-function cabled interface and one Ethernet data interface. Because the Adaptor is physically small, the capacitance from the enclosure to ground is negligibly small at the frequencies relevant for conducted testing. Therefore the PLA is effectively a two-port item and so ***whatever common-mode current flows in or out through the mains port must flow out or in equally through the data port. There is nowhere else for it to go*** (Kirchhoff's first law). The presence of the earth conductor in the mains cord would be a complication, if it were not that these PLAs are double-insulated and make no use of the mains earth other than routing it to the built-in mains socket.

Of course, the dual-function mains port is designed to minimise the launch of common-mode power, but *any unbalance in its external load will create a common-mode voltage there* and the resulting current flow back into the PLA from the mains must flow out of the PLA via the data cable. This appears to be the root cause of the disparity between the test results.

The mechanism is analysed in the basic circuit of Figure 1.

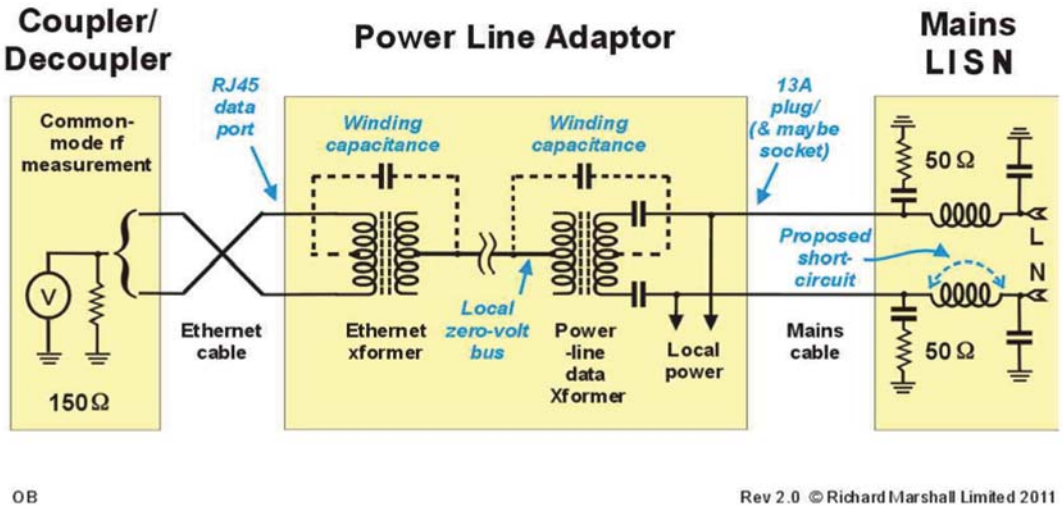

Figure 1. A single power line Adaptor is shown with examples of the support terminations. For clarity both the second pair in the Ethernet cable and the second PLA required to exercise the PLA under test are omitted here.

It can be seen that provided the mains source impedances to ground from each of the Live and neutral wires are equal, as in the case of the Line Impedance Stabilisation Network (LISN) shown here on the right with its two 50 ohm resistors, there will be no powerline data voltage relative to ground at the PLA data transformer centre tap, and so almost none of this signal will be coupled onto the Ethernet cable on the left. However, if for example the impedance on the Neutral side is zero, then *half* the powerline data voltage will be returned to the Power Line Adaptor as a common-mode signal and appear at the data transformer centre tap. From there it will be coupled onto the Ethernet cable via the series impedance of the interwinding capacitance of the powerline data transformer, the local zero-volt bus, and the capacitance of the Ethernet transformer. There will also be a parallel coupling route via the local power circuitry. Since the powerline data voltage is very large in EMC terms, the effect of this coupling is potentially very severe.

On the other hand, if the test is set up with a well balanced mains network then the Ethernet port test will only "see" the emission due to any inherent unbalance of the Ethernet circuitry itself.

Some tests have been undertaken to verify this theoretical analysis, using the EN55022 test set-up but various mains impedance conditions for the pair of PLAs. The results are as follows;

Table 1: Emissions onto an unshielded data cable with various mains impedance conditions. *In all cases the two 9020 PLAs were plugged into a 13A distribution strip attached to 1 metre of cable from the LISN or wall socket. To give the LISN maximum control over the mains impedance its ground connection was returned directly to the ground plane it shared with the data cable CDN. The measured voltages are peak, as recorded by an HP8594E Spectrum Analyser, in 10KHz bandwidth, measured using an RML S46ST8 telecommunications CDN and taken at a time when the PLAs were operating at maximum send level on the mains/data port but zero data rate on the Ethernet port.*

Frequency	CISPR LISN	CISPR LISN with Neutral Inductor short-circuit	CISPR LISN with 50 ohms across Neutral Inductor	**Direct to laboratory mains**
7.65MHz	53.68dBµV	69.94dBµV	63.07dBµV	**65.35dBµV**
12.90MHz	58.09dBµV	75.04dBµV	66.57dBµV	**70.74dBµV**
17.45MHz	58.66dBµV	75.08dBµV	70.17dBµV	**77.99dBµV**
22.84MHz	63.52dBµV	77.20dBµV	67.68dBµV	**69.34dBµV**

Note that there is up to 19dB difference between the set-up using the standard CISPR16 LISN (as was done in the referenced Blackwood test) and plugging directly into the laboratory mains (as appears to have been the case at RFI Global.) Furthermore the direct mains results vary much more over the frequency range than those based on the LISN suggesting resonance effects in the mains network: This distinction is also very evident from the plots in the references.

We have been fortunate to secure the co-operation of Blackwood Compliance Laboratories, who have undertaken similar tests under their accredited standard test conditions. These differ from those applied for Table 1 in that the cable lengths were much greater (CDN to EUT 1.5 metres, EUT to LISN 2.0 metres) and the data channel was operating at its maximum data rate. Figure 2 shows the relative conducted emission on the data cable with the CISPR16 LISN (black trace) and the same LISN with deliberate unbalance (green trace).

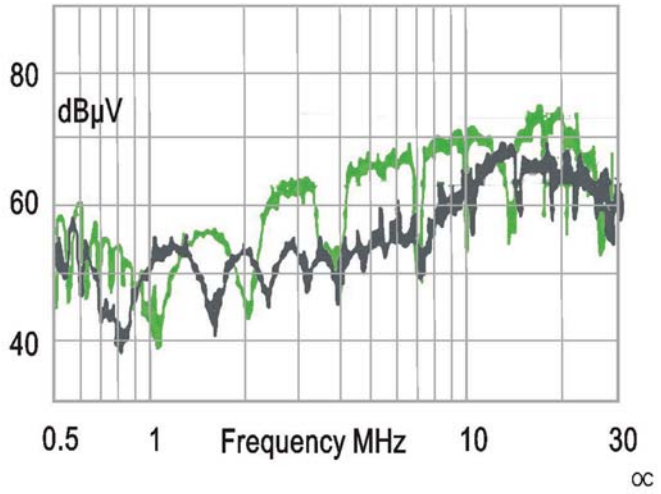

Figure 2. Peak conducted data-cable emission from a Powergrid 9020 Power Line Adaptor, as measured with the mains cable balanced by a CISPR16 LISN (black plot) and with the same LISN unbalanced by a short across the 50µH neutral inductor (green plot) Data has been extracted from Blackwood report R11-2233A and is published with their permission.

The outstanding feature of these plots is the increase – typically 10dB – in the amplitude shown by the green (unbalanced) plot. This increase follows the characteristic PLT spectrum, starting at 2MHz and with notches for the amateur bands. The effect becomes somewhat less evident above 10MHz. Presumably this results from some masking by genuine emission from the EUT's data launch circuitry together with increasing attenuation of the reflected interference from the mains source by the cables and the shunt capacity to ground of the EUT. Such attenuation is to be expected since the total path length from EUT to CDN for reflected mains emission is twice the mains cable length plus the data cable length – a total of 5.5 metres in this set-up.

Discussion:

It is clear from these measurements that the influence of the mains cable impedance on the Ethernet cable emission is as profound as would be expected from the above theoretical analysis. It adequately explains the difference between the results given in the reports of the referenced test laboratories and demands clarification of what are appropriate test conditions for testing the EMC of power line modems. It is clear that the mains cable and its source impedance needs to be specified and managed even when the actual measurement is of data cable emission.

As ref. 5 says of the ERA/RFI results; "*examination … suggests that there may have been significant coupling of the powerline signals onto the Ethernet cable thus affecting the accuracy of the results"*

But what represents "accuracy" in this context? What is the test trying to emulate?

The strategic answer, of course, is that a Standard should represent real-life operational conditions to the greatest extent possible without unduly compromising test expense or test reproduceability. A well-balanced *mains* configuration may give minimum Ethernet cable emission but is clearly not representative of real life. This is supported by the common observation that BTVision installations are characterised by significant HF emission from the telephone drop wire , and the fact that in the UK we do, in many installations, solidly ground our neutral conductors.

The requirement of CISPR 22 (EN 55022) is very unclear. On the one hand, Para. 8 states that "… the EUT shall be configured, installed, arranged and operated in a manner consistent with typical applications. … each cable shall be terminated in a device typical of actual usage. … It is important that any simulator used … properly represents the electrical … characteristics of the interfacing ITE, especially RF signals and impedances." [Ref. 6 discusses this in a related context.]

CISPR16-2-2 preaches likewise at para. 6.3.5; "The EUT shall be operated under practical conditions which cause the maximum disturbance …".

On the other hand the test layout in figure 4 of CISPR22 does show the mains supplied via a LISN.

There does not appear to have been any acknowledgement that conversion of differential-mode interference to common-mode is inherent in the mains supply network, and that this emission returns to the EUT – and through it to the EUT's other cables.

Emission standards lack any specification of the impedance balance of the mains supply to the EUT. The possibility is not mentioned in section 4 of CISPR16-4-2. No problem has been evident prior to the introduction of PLT devices with their very high differential-mode emission, but the effect must always have contributed to the measurement uncertainty of conducted and radiated emission testing.

This paper has concentrated on the problem for conducted measurements below 30MHz, but similar recommendations would almost certainly apply to the test conditions for *radiated* measurements at higher frequencies, where the balance of the impedance of the mains will affect the emission from the mains cable *and from other cables connected to the EUT*.

The work set out above confirms that the problem exists and that the problem can be avoided in future - and typical mains distribution impedance simulated in a repeatable and representative way - by *mandating the use of a V-network LISN such as described in CISPR16-1-2 para. 4.3 and figure 4 with its Neutral Inductor L1 short-circuited* whenever radiated emission, and conducted emission from non-mains ports is being determined. Note that for those implementations of this LISN that do not have any internal attenuation of the measuring receiver output the same effect can be achieved externally by selecting the "N" output and then replacing the measuring receiver connection by a short-circuit. This would leave the LISN seals and calibration validity intact. Of course this modified LISN only provides the desired reproduceable unbalance at the higher frequencies when it is equipped with a low-inductance bond to the groundplane and has the standardised cable length to the EUT.

Our theme – that EMC testing should always be performed with realistic mains supply impedance and balance – also has

implications for the design and application of the CDNE that is currently under development by CISPR. See CISPR/A/944CD [ref.7] and the related UK comments.

Recommendations:

It is a matter of some urgency to define the source impedance and balance of the mains connection to a PLT device and any other 2-port EUT whilst measurements of the conducted emissions at the other port are being made. The definition should represent the real-world situation and not an artificially benign situation. An appropriate source impedance could be provided quickly and cheaply by specifying a *modified* mains V-network LISN/AMN according to CISPR16-1-2.

Such action requires an amendment to the current CENELEC PLT draft FprEN50561-1 and its descendents, amendment to CISPR16-4-2, and an interpretation note to CISPR22.

Acknowledgement:

Blackwood Compliance Laboratories have been very supportive of this work and the author greatly appreciates their contributions.

References

[1] http://stakeholders.ofcom.org.uk/enforcement/spectrum-enforcement/plt/

[2] The ERA-RFI report 2008-0578 is accessible within the "Associated Documentation" folder of ref.1

[3] The RFI Global test report RFI/EMC2/RP73935JD01A is accessible within the "Associated Documentation" folder of ref.1.

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[5] "*EMC compliance of Comtrend PG902*" Trevor Morsman, presentation BT-PG902 is accessible within the "Associated Documentation" folder of ref.1.

[6] "*The trouble with Wall-Warts*" Tim Williams, The EMC Journal, Issue 58, May 2005

[7] "*Introduction of the CDNE for emission measurement*" CISPR/A/944CD, April 2011, BSI private circulation GEL/210/12_11_0039.

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Multi-tone Testing can save both Time and Money

By Jason Smith, Manager Applications Engineering &
Pat Malloy, Sr. Applications Engineer, AR RF/Microwave Instrumentation

Given the huge amount of time required to conduct a radiated immunity test, it is no wonder operators "dream" of ways to improve efficiency to speed up the test. The musings generally go as follows:

- Can one antenna cover the entire frequency range?
- Can RF switching be automated?
- Let's add a controller to automatically switch antenna polarizations or even go as far as automatically turn the EUT to expose all four sides to the RF field.
- What if we could speed up the dwell time just a hair without compromising the test?

While all of the above thoughts are useful, they only decrease transition times, which unfortunately comprise only a fraction of the total test time. What if there was a way to dramatically reduce test time while still meeting the stringent requirements of the test standard? This would certainly be a dream come true.

Take heart…a way has been found. The title of this article provides a hint as to how this can be accomplished. AR RF/Microwave Instrumentation has developed a product which uses a patented test process that adds additional test frequencies, or tones, for each test period, or dwell time. Rather than testing one tone per dwell period, we add additional tones to effectively increase the test efficiency by a factor approximately equal to the number of tones used. For example, if four tones were used, the test would be completed in about one quarter of the normal time or four times faster.

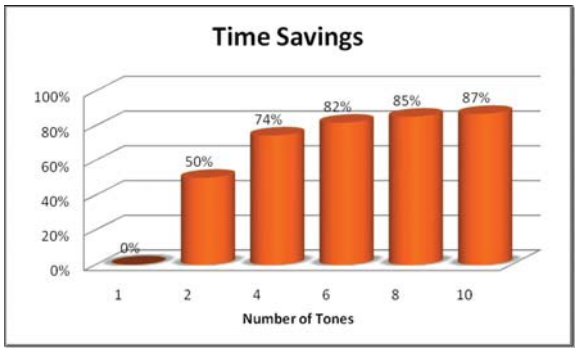

Figure 1: % time savings for dwell time

Multi-Tone concept

Since the concept of using multi-tones is so obvious, one wonders why it hasn't been used before. While simple in concept, the actual hardware implementation has always been a hurdle. Multiple signal sources simultaneously controlled and properly combined in a repeatable fashion has been beyond the scope of readily available test instrumentation. Fortunately, a recent breakthrough in signal generators has provided instruments that meet the stringent requirements of multi-tone testing. While the good news is that the signal generation dilemma has been solved, there are other considerations one must deal with when configuring a multi-tone test. For example, how is the power amplifier affected by the introduction of multi-tones? Does this method comply with the requirements of the test standard? In our attempt to reduce test time, do we comprise the results in any fashion?

As for the effect on the system power amplifier, it has been determined that power requirements are additive. Therefore, a two tone test requires a power amplifier twice as large as the one specified for a standard one tone test. Accordingly, a test consisting of five tones would necessitate a power amplifier five times the base size. The introduction of inter-modulation products resulting from two or more tones will also call for additional power. This effect can be minimized by using a Class A power amplifier within its linear region. Given the complexity of combining more than one test signal while adhering to stringent signal integrity requirements, sophisticated control test software has been developed. This proprietary software uses complex algorithms to measure and find the maximum number of tones possible while staying within the constraints of a valid multi-tone test.

Determination of required amplifier power

One of the limitations of multi-tone testing is the maximum available amplifier power. One tried and true approach in determining amplifier power is to determine the minimum amount of power needed to generate the required test field per the IEC 61000-4-3 radiated immunity test and double it to account for system losses. Since required power varies as a function of frequency, the only way to reliably determine the necessary power is to perform the standard IEC 61000-4-3 uniform field calibration. Figure 2 is a typical plot of the requisite power as a function of frequency. Note that required power falls off rapidly with frequency. Here multi-tone testing could take advantage of the full (formerly unused) power of the amplifier and reduces overall test time. In this specific case a 250 watt amplifier would provide a 2x speedup at the lower frequencies with a much greater reduction in test time at the higher frequencies. In many cases test labs have the power to produce high fields but are testing at lower levels most of the time. With multi-tone testing, test labs could make better use of their unused amplifier power while reducing test times. The argument for adding higher power amplifiers to the test lab has become a little easier since not only will the addition allow for testing at higher field levels, but now the additional power can result is a reduction in test time.

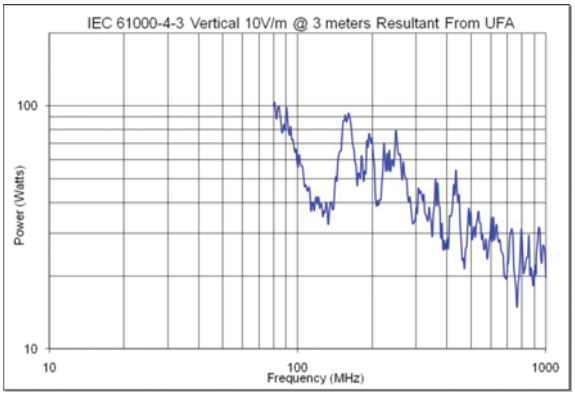

Figure 2: Required power for 10V/m from UFA calibration

IEC 61000-4-3 Radiated immunity 80 MHz – 6 GHz Calibration

This test standard very clearly explains the calibration and testing procedure which must be followed to demonstrate compliance. The lengthy 16 point calibration process uses isotropic field probes which are not frequency selective and cannot parse out and measure multiple tones. Therefore, the calibration time cannot be improved using a multi-tone process. The same procedure conducted for the yearly uniform field area calibration is still followed and the results are then evaluated to determine the suitability and extant for multi-tone testing.

Linearity and harmonic content measurements are required as part of the calibration process. When a multi-tone test is planned, it should be understood that ***all*** tones must undergo these measurements as well as additional tests. The extra checks use the same criteria noted in the IEC specification for linearity and harmonics and are required in order to define the maximum number of tones that can be used at any given point in the test. At this point, the multi-tone grouping is established for the multi-tone test process.

Testing

Once a determination of how many tones can be used and at what points in the test, testing can proceed at record speed. For each dwell time a set of tones is presented to the EUT. If there is no EUT fault, the test continues. If a fault occurs, the user has the option to immediately investigate with a single tone to verify if the failure also exists when only a single test frequency is used, or continue with the multi-tone test noting where failures occurred. In the second case, after test completion, the failed frequency ranges would be rescanned with a single tone to see if the fault is unique to multi-tone testing or remains even when testing with a single frequency. Additional investigation and threshholding can also be performed at this time. If the EUT demonstrates sensitivity to multi-tones but not with a single tone, the EUT is considered compliant with the test standard. The only downside is that at least at these particular frequencies, one can not reduce the test time. Nevertheless since large sections of frequency ranges can be scanned and tested quickly, overall test time is still reduced.

While the individual tones used in multi-tone testing do not overstress the EUT, the additional energy obtained from combining two or more signals may induce a response in the EUT that is outside the scope of the test standard. If this occurs, the fast testing approach must be suspended in favor of the conventional single tone test. If the EUT continues to fail when subjected to just one test frequency, then testing has indeed uncovered a weakness that must be resolved. Keep in mind that the rational for multi-tone testing is saving time. In the final analysis, the IEC 61000-4-3 standard only requires that the EUT be subjected to one test frequency at a time. Therefore the methodology should be to operate with multi-tones where possible to save time but to step back to single tones when a fault occurs. The graphical representation in Figure 3 captures this testing concept visually. Note that the test proceeds quickly from the lowest frequency up to a point where a fault is encountered. At this point multi-tone testing is suspended and the test reverts to single tone conventional testing. In this hypothetical scenario, it is seen that the EUT passes the single tone testing and multi-tone testing is resumed without further failures throughout the remaining frequency range.

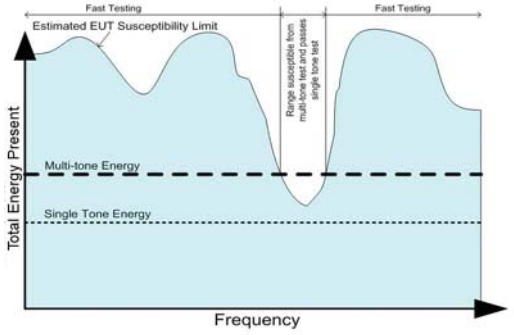

Figure 3: Simulated multi-tone test

Compliance

The EMC standard is always adhered to with the AR RF/ Microwave Instrumentation implementation of multi-tone testing. The major difference between conventional testing and our approach to multi-tone testing is that testing is much faster. For calibration we follow the same procedure outlined in the standard and can level on either forward power or field level without variation. The 2 dB allowable compression margin is checked and used as a criterion for finding how many tones can be used. The harmonic requirement of -6dBc (dB from carrier) in the field is used as a second check on the maximum number of tones used. Once the tone sets are found, they are then used for all multi-tone testing. While the number of allowable tones is determined automatically, the user has the ability to override the software and reconfigure the maximum number of tones in each tone set.

Each and every tone during the test:

- will be at the correct amplitude to produce the needed field
- will be at the required frequency
- will be at the required frequency % step, or in this case % spacing
- will carry the required modulation of 1 kHz, 80%AM
- will dwell at the required dwell time for each frequency/ tone

It can be seen that all the requirements of the EMC standard are met. The ability to test and demonstrate compliance while significantly reducing test time is now a reality and we are pleased to announce that “the dream has come true”.

Future

One of the future applications of this technology would be to mimic real world threats which are multi-tone in nature. Real world applications expose EUTs to more than one tone at a time. Conventional one tone testing would never uncover susceptibility to these “actual” threats. Some equipment manufacturers have already experienced multi-tone induced EMC failures and have been using multi-tone testing to identify and correct product vulnerabilities. The AR multi star (MT06000 Multi-Tone) test system could make such a task easier to setup and test with the built in algorithms to verify and make sure the signal is not effected by anomalies from inter-modulation products caused by non-linearity.

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See us on Stand 65

EMC design of high-frequency power "switchers" and "choppers"

Design techniques for LF (mains) rectifiers

One of a number of "Stand Alone" articles on the EMC design of switch-mode and PWM power converters of all types

By Keith Armstrong, Cherry Clough Consultants Ltd, www.cherryclough.com

Issues 93 – 95 of The EMC Journal carried earlier parts this "Stand Alone" series, which is my attempt to cover the entire field including DC/DC and AC/DC converters, DC/AC and AC/AC inverters, from milliwatts (mW) to tens of Megawatts (MW), covering *all* power converter applications, including: consumer, household, commercial, computer, telecommunication, radiocommunication, aerospace, automotive, marine, medical, military, industrial, power generation and distribution, whether they are used in modules, products, systems or installations.

I also aim to cover hybrid & electric automobiles, electric propulsion/traction; "green power" (e.g. LED lighting); and power converters for solar (PV), wind, deep-ocean thermal, tidal, etc.

I will generally not repeat stuff I have already published, instead providing appropriate references to material published in the EMC Journal [14] and my recently-published books based on those articles [15]. The reasons for this are three-fold:

- So that you don't get bored by repetition
- To help save a few trees from an early death
- To help avoid building extra server centres for the Internet

The latter two bullet points you will of course recognise as being vital for reducing the human emissions of CO_2 that are acidifying the ocean and will most likely lead to the total collapse of several major global food chains, mass starvation, etc., etc. within the lifetimes of anyone under 50. We must all do our bit!

You will of course have noticed that the numbering of the sections does not correspond to the number of the published part of the series (this is the fourth Part), and I hope you can forgive me for this. At least from this Part on I will be numbering my figures in a more sensible way!

5 EMC design of LF (mains) rectifiers

The first possibility, is to use the type of converter described by Slobodan Ćuk in [42] that does not require an input rectifier at all.

But if we *are* going to increase the cost of the Bill of Materials (BOM) by using a mains rectifier, we will often have to further increase the BOM cost to deal with the switching noises and harmonic/interharmonic currents it emits.

5.1 Suppressing LF rectifier Radio Frequency (RF) noise

When a rectifier is forward-biased and carrying a current, its silicon body contains minority carriers (often called "holes"). It is the presence of minority carries that makes the silicon conduct, and when the rectifier's voltage is reversed these minority carriers take a short time to decay to the point where the silicon becomes insulating again. So, for a short time, the rectifiers carry current even though they are reverse-biased, causing unwanted emissions at harmonics of the switching frequency that extend all the way from 150Hz up to (and into) the RF bands.

The faster the switching speed of the rectifiers, the more the emitted noise extends to higher frequencies, so this type of noise is a big problem for HF rectifiers and it is discussed in more detail in 6.2.

Low Frequency (LF) rectifiers are used on mains supply frequencies between 16.67Hz and 400Hz (most of them at 50 or 60Hz) and switch relatively slowly, so this type of noise is probably not the main cause of their RF noise emissions. If it is a significant cause, using silicon carbide Schottky rectifiers will stop it (Schottkies don't have minority carriers). These are now becoming available with ratings to 1kV and more, and of course they cost more but as I keep telling people the BOM cost alone does not determine the profitable selling price, see [12].

But most likely the largest source of noise in an LF rectifier comes from the fact that silicon (PN junction) rectifiers are non-linear devices and the voltage needed to turn them on (make them conduct) is around 0.7V, depending on the forward current. So a bridge rectifier (whether PN Junction or Schottky) has a "deadband" of around 1.4V (for a PN junction type) where it is not conducting either one way or the other.

For the LF rectifiers being discussed, both noise sources can be dealt with by adding capacitors in parallel with the rectifiers themselves, as shown by Figure 5.1.

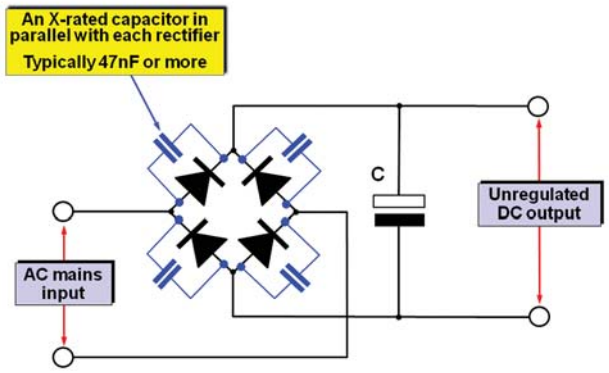

Figure 5.1 Suppressing the RF switching noise emitted by a mains bridge rectifier

Where the bridge rectifier is in the primary of the mains circuit, these capacitors must be safety-rated types. See section 5.2.12 of [5] for why it is necessary to ensure that all safety-rated capacitors really are what they claim to be, if your company is not to be held liable for accidents caused by the mistakes or frauds of your component suppliers.

But if the bridge is in the secondary of a safety-isolating mains transformer, it is only necessary for these capacitors to meet their appropriate maximum ratings, and for the design not to cause a fire or electric shock hazard if one or more of these capacitors fails.

To pass the conducted emissions limits in EN 55022 (CISPR22) or EN 55011 (CISPR11) class B, I have *so far* only found it necessary to suppress 50/60Hz mains rectifiers rated at more than 1kW, and then using (*very* approximately) 100nF per kW. But I cannot claim that the above is a proven good EMC practice, so it is probably a good idea to provide prototypes with converters rated at more than 100W with pads suitable for a range of sizes of appropriate X-rated capacitors. If they are not required, they can be omitted from the production versions, but at least there will be room on the board for them if they are found to be required by EMC testing late in a project, when modifications that were not allowed for can be very costly (see "anti-Murphy design" at the end of section 4.1 of [5]).

5.2 Suppressing harmonic and interharmonic emissions

5.2.1 Introduction

I have described this topic in great detail for electronic design engineers in Chapter 10 of [5]. So I won't repeat what it says here. And I also won't repeat what I have written on this topic for systems and installations engineers in [3], [7] and [8] (which have the great advantage of being free).

When attempting to control the harmonics in systems and installations, most people focus on the larger loads, usually variable speed AC and DC motor controllers rated at 100kW or more (mining industries and the main propulsion of ships can use variable speed drives to 10MW).

A good example of harmonics causing serious safety problems due to interference with control electronics is given in Banana Skin No. 618, published in the January 2011 Edition of the EMC Journal (and available from the archives at www.theemcjournal.com).

But in modern electrical installations *all of the loads can be electronic*, and the aggregation of the harmonic emissions from large numbers of low-power equipment, such as cellphone and laptop chargers; compact and high-frequency fluorescent and LED lighting, etc., can also create significant levels of harmonic distortion, as [53] shows.

So, I always recommend that *all* electronic product/equipment designers reduce harmonic emissions from their mains rectifiers, even where harmonic emissions standards such as IEC/EN 61000-3-2 or 61000-3-12 don't set any limits, or allow very relaxed limits (as they do for all lighting equipment).

Reduction of harmonic emissions is often known as Power Factor Correction (PFC), but it is important not to get confused with the term 'Power Factor' as traditionally used by electrical supply engineers – which simply means the cosine of the phase angle between the sinewave supply voltage and a sinewave load current. This is more correctly called "Displacement Power Factor" and is only relevant for linear loads – which, of course, rectifiers are not.

We are interested in "True Power Factor" – which is simply the ratio of the VA to Watts.

I am always eagerly homing in on advertisements for power factor correction, only to find that they are simply about capacitors and only suitable for Displacement Power Factor correction. We cannot ever correct the mains power factor of rectifiers just by adding a capacitor to the mains (although we can get some improvement by adding a series choke to the mains, see 5.2.6 below).

Another cause of misunderstanding, this time with potentially deadly effect, is that the actual problem of harmonic (and interharmonic) emissions is due to the current noises generated by non-linear circuits, for example measured as I_{thd}. But standards such as IEC 61000-3-2 and -3-12 choose to measure their emissions as the voltage noise that these currents cause (e.g. as V_{thd}) in standard impedances chosen to be typical of AC mains distribution systems.

Because the harmonic/interharmonic measurement standards measure V_{thd}, system and installation designers can be lulled into a false sense of security by thinking that this is what they can expect when an equipment is connected to *any* mains supply. But in real life, the actual mains distribution systems can have very different impedances, especially when they are powered by a generator. This is because a generator of a given kVA rating typically has a source impedance three or four times that of an HV grid transformer of the same rating, so the same harmonic current noise can cause significantly increased V_{thd}.

So, for example, a hospital might manage a V_{thd} of under 5% when running of the national HV grid – a value generally considered to be acceptable for normal electrical equipment (e.g. motors) and electronic equipment. But they might get many nasty surprises with malfunctioning equipment, flickering displays and lighting, including significant functional safety, fire and explosion risks, when switching to their back-up

generators makes the distortion of their AC mains supply jump up to 10% or more.

It seems to me that engineers would be a little more aware, have a little more understanding of the real-life issues of harmonic distortion of the mains supply, if equipment emissions were measured and specified as currents. Then they would have to think about the possible impedance range of their mains power distribution network to ensure that V_{thd} remained under (say) 5% for all reasonably foreseeable operating conditions.

The real-life issues of distorting the mains supply with harmonics/interharmonics are huge, from lighting flicker, through equipment malfunctions, to fire and explosions of any magnitude. [8] has a brief introduction to this on pages 23-26, but [7] goes into much more detail in its pages 7-28 (it's OK, these 21 pages are A5 sized and use large font size – you can read them all in five minutes!).

But something that [7] and [8] don't emphasise enough is that AC motors are designed to operate at up to a specified maximum temperature ***assuming*** that their AC supply has less than a certain percentage of V_{thd} (usually 5%). If the mains distortion exceeds this they can run hotter than their rated maximum temperature, leading to reduced operational life – if not actual insulation/bearing failure that causes catastrophic failure.

But there is worse. I remember reading somewhere that something like 30% or more of industrial areas worldwide have Explosive Atmospheres, and in these areas a motor that runs excessively hot and above its temperature class, or has bearings that collapse due to the evaporation of their lubrication, can cause fire or explosion. Such fires and explosions can be huge, leading to great loss of life and financial damage to the operating company and their owners. Think of the explosive atmosphere fire and explosion disasters in the UK alone, for example Flixborough (http://en.wikipedia.org/wiki/Flixborough_disaster); Buncefield (http://en.wikipedia.org/wiki/Flixborough_disaster); Piper Alpha (http://en.wikipedia.org/wiki/Piper_Alpha), and Texaco Milford Haven (www.hse.gov.uk/comah/sragtech/casetexaco94.htm) which significantly depressed the UK's gross National Product for a year or more.

This is especially a problem for *offshore* explosive atmospheres, such as gas and oil production platforms and drilling rigs of various types, because they run on generators with a preponderance of their load going to high-power variable-speed motor drives. Their V_{thd}s can be between 15% and 30%, sometimes even more at times, although their V_{thd} limits are supposed to be either 5% or 8%.

The design of EX-rated motors (and the like) is usually based on a harmonic distortion factor (HVF) of 2% (around 5-6% V_{thd}) to limit the temperature rise and to suit their explosive atmospheres, but many operators seem to ignore that they are only EX-rated if their mains supplies have V_{thd}s of 5% or less. It appears that a very important safety risk caused by harmonic emissions is often being ignored, and for more on this and similar problems see [54].

5.2.2 The mains harmonic and interharmonic currents emitted by a bridge rectifier

Electronic engineers should refer to section 10.1 of [5], and systems and installations engineers should see pages 2-7 [7] and page 20 of [3].

The title of this section is a little misleading (but only a little) because bridge rectifiers themselves, with DC storage capacitors and pure unchanging resistive loads can only create harmonic currents. Fluctuations in load current in the frequency range below 10kHz are filtered somewhat by the unregulated DC storage capacitor and then pass through the rectifier and into the mains supply as low-frequency currents that are not harmonically related to the mains frequency of 50 or 60Hz.

So, for example, a very high-power audio system could cause nearby streetlights to flicker in time with the music. And a variable-speed AC motor drive with a PWM output frequency of, say, 39Hz emits interharmonic currents into the mains supply not just at 39Hz, but also at harmonics of 39Hz. It may even be that the emissions of mains harmonics are much less than the emissions of interharmonics.

But the interharmonic situation is actually much worse than this, because bridge rectifiers are non-linear they act as frequency mixers, producing intermodulation products between the mains frequency (50 or 60Hz and all of their harmonics to beyond the 50th) and the load current's spectrum (e.g. 39Hz and all of *its* harmonics to beyond the 50th).

Figure 5 of [7] is reproduced here as Figure 5.2-1, and originally came from Figure 13 of [55]. It shows a spectrum graph of the noise currents emitted from a high power (several hundred kW) AC drive. This is a very rich noise spectrum, with about 120A of current at its output frequency of 39.375Hz and about 30A at its fifth harmonic (nearly 200Hz), but with only small currents (< 1A) at the mains frequency of 50Hz and its harmonics.

It also shows 24A of emissions at 103.75Hz (6th harmonic of 50Hz minus 5th harmonic of 39.375Hz); 12A at 131.25Hz (6th harmonic of 50Hz minus 11th harmonic of 39.375Hz); 7.73A at 260.635Hz (5th harmonic of 50Hz minus 1st harmonic (fundamental) of 39.375Hz), and so on.

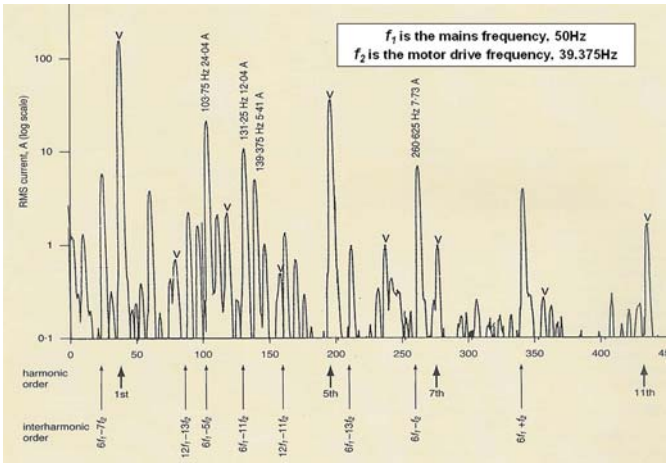

Figure 5.2-1 An example of real harmonics and interharmonics

Interharmonics can extend down to 1Hz or less, and for example Figure 5.2-1 shows about 8A of mains supply emissions at about

25Hz (6th harmonic of 50Hz minus 7th harmonic of 39.375Hz).

It is often assumed that harmonics are the main cause of problems on mains distribution networks, rather than interharmonics, but Figure 5.2-1 shows that, for the inverter measured, mains harmonic emissions are actually very low. Its noise emissions into its mains supply are almost entirely its output frequency of 39.375Hz plus its harmonics, plus intermodulation products between them and the 50Hz mains frequency and its harmonics.

Measuring its mains currents only at the mains frequency and its harmonics, using a very narrowband measuring system, would indicate very low emissions indeed. A practical engineer with some experience would automatically check the consumption at the fundamental frequency, to see if it made sense. He or she would suspect such data because it implies that a motor that was delivering several hundred kW of real work, was consuming less than 1A from the mains at its fundamental frequency of 50Hz!

The first temptation when such things occur is always to want to patent it quickly – energy from nothing! But anything that appears to contradict the Law of Conservation of Energy is *always* wrong, which is unfortunate for global warming (more often called "climate change" in the USA).

Most harmonic measuring systems have measurement bandwidths wide enough to include many of the nearby interharmonics, but only displays the results *as if* the emissions were all occurring at the mains frequency and its harmonics. This may be why it is generally assumed that interharmonics are not a big concern, when Figure 5.2-1 indicates that they may in fact be the greatest concern for power frequency converters.

High-power switching converters can have switching rates of 5kHz or less, and so appear in the same frequency band as mains harmonics, and be measured as such. For example, Figure 5.2-2 shows that the 2kHz switching frequency of the IGBT choppers in a 600Vac 700kW variable-frequency AC motor drive appears as the 40th harmonic of the mains. It just so happens that the 40th harmonic of 50Hz is exactly 2kHz, so when a chopping frequency falls between two harmonics, for example 1.975kHz, whether the full level of the problem is measured depends on the bandwidth of the harmonic measuring instrument at the harmonic frequencies.

5.2.3 Differential Mode (DM) and Common Mode (CM) harmonic emissions

Harmonic current emissions have two modes of propagation:

- DM – where they flow out on one phase and back on another (or on a neutral)

- CM – where they flow out as a common current on all phases and any neutral but return via the earth/ground conductor or earth/ground structure

DM currents flowing in the impedances of the phases and neutrals cause the AC mains supply voltage waveform to distort, e.g. V_{thd} (although proper analysis requires that the distortion caused by each harmonic component is measured).

CM currents flowing in the impedance of the earth/ground cause voltage differences between items of equipment, giving rise to so-called "ground loop currents" that cause problems for inadequately designed electronic equipment. (Just because an electronic design meets its functional specifications on a test bench, does not mean it will meet them in a real-life system or installation, but attempting to solve the problem by breaking "ground loops" by using single-point earthing in systems and installations causes all manner of EMC problems, see section 4.6.8 of [5], [61], [62] and [63]).

All of the techniques discussed above will reduce the emissions of DM harmonics – hence reduce the V_{thd} of the AC mains supply. This is often the only thing that anyone thinks about, until they have CM problems in real life. But only some of the techniques work to reduce the CM harmonic noise.

Banana Skin No. 618 (in the January 2011 Issue of the EMC Journal, available from the archives at www.theemcjournal.com) was a CM harmonic problem that cost $54 million before it was solved, and Figure 5.2-2 reveals the scale of the problem on the offshore platform concerned.

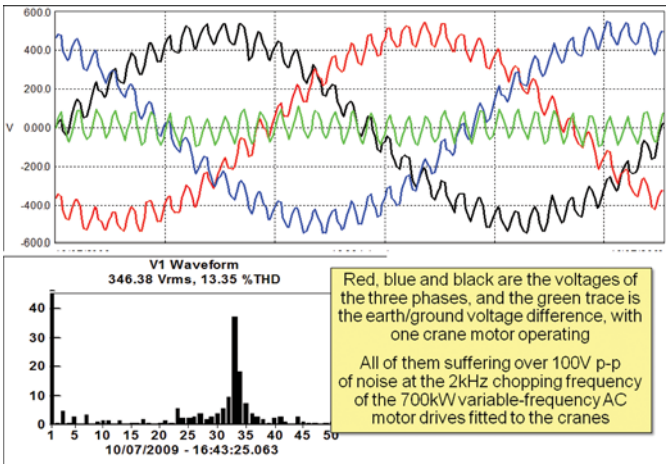

Figure 5.2-2 Examples of the mains waveforms from Banana Skins No. 618

As the caption on Figure 5.2-2 indicates, the DM noise on each phase of the platform generator's AC mains supply was about 100V p-p (the black, red and blue waveforms), and so was the CM noise in the earth/ground (the green waveform plot), when one of its 700kW crane drives was operating.

This CM noise upset the operation of crane control electronics, causing the crane to flail about with obvious safety problems. Some of the cranes on the platform were more badly affected than others.

The problem of crane control was dealt with by putting isolating transformers in series with the supply to each of the 700kW crane drives – the sources of the CM noise currents – as shown by Figure 5.2-3.

Figure 5.2-3 The fix for the CM noise from the crane motor drives

These isolating transformers did nothing for the DM harmonic currents, and so the V_{thd} of the platform's AC mains supply remained the same when the cranes were operated. But the green waveforms are now almost flat lines – the CM currents, and hence earth/ground noise voltages, having been attenuated by about 20dB by the transformers.

5.2.4 Using smaller values of DC storage capacitor after the bridge

Electronic engineers should refer to section 10.2 of [5]. This is an equipment design technique, not appropriate for systems and installations engineering, and it works on both DM and CM harmonic emissions.

5.2.5 Passive filtering

Electronic engineers should refer to section 10.3 of [5], and systems and installations engineers should see pages 52-54 of [7]. This method works on DM and/or CM harmonic emissions, depending on the design of the filters.

Because it is impossible for a low-pass filter to get high levels of attenuation of low-order harmonics without wasting a lot of power at 50 or 60Hz and running hot, where high attenuation is required it is normal practice to use "resonant trap" filters, tuned to the 3rd and other low-order harmonics.

They are used in parallel with the mains, to provide very low impedances at their tuned frequencies; and/or in series with the mains supply, to create very high impedances at their tuned frequencies. Traditional low-pass filters are generally used for attenuating all the harmonic emissions above the 7th.

Where resonant trap filters are used to reduce harmonics in installations, it is normal practice not to tune them exactly to the harmonic frequencies. Based on a detailed site survey that covers all modes of site operation, the filters are tuned to one side or the other of the harmonic so as not to increase the risks of voltage instability due to system resonances (see pages 44-46 of [7]).

So, if you want to use passive harmonic filters on your system or installation, I always recommend employing professionals with a proven track record in your type of system or installation (ask for references), instead of trying to do it yourself.

There is another type of passive harmonic filter that is unlike traditional passive filters, typically used in large systems and installations worldwide, including offshore. Called a "wide spectrum filter" it uses a proprietary design based on multi-limbed inductors (chokes) wound on a common core and fitted with a small bank of capacitors.

These filters are connected in series with the load(s) and – depending on manufacturer – can reduce I_{thd} to around 5%. One manufacturer supplies these filters with ratings up to almost 3,000kW for use with both AC and DC motor drives. Being passive and linear, they do not add to any EMI emissions. A Google search for these wide spectrum filters turns up www.mirusinternational.com/pages/lineator.htm and www.harmonicsolutions.co.uk/solutions/solutions1.html, probably good places to start learning about this proprietary technology.

Passive filtering of interharmonics gets progressively more difficult/costly at frequencies below 100Hz due to the physical size of the components, plus it is difficult to filter interharmonic frequencies that are within ±20% of the mains frequency due to power losses in the filter.

5.2.6 Series chokes ("reactors") in the DC or the AC supply

A warning about terminology

I tend to use the word "choke" as a synonym for (means the same as) inductor, and most electronic designers would find this unexceptional. But in electrical systems and installations they tend to refer to inductors as "reactors".

This seems very odd to me. I think of an electrical reactor as a component that produces reactive impedance, which means that capacitors are reactors as well as inductors. But the common usage in systems and installations is that a "reactor" means an inductor (a choke) and "reactance" is inductive impedance, whereas a capacitor is a capacitor and creates capacitive impedance. It is faulty terminology that can lead to misunderstandings, so beware!

Now back to the plot….

Electronic engineers should refer to section 10.4 of [5], which concerns adding chokes in the DC rails between the bridge rectifier and its unregulated storage capacitors. This method works on DM and/or CM harmonic emissions, depending on the design of the chokes.

Of course, systems and installation engineers cannot add series chokes in the DC power rails of purchased equipment without invalidating their warranties (and probably also considerably reducing their reliability).

But they *can* (and do) add series chokes in the AC mains supplies to the purchased equipment, and this common technique is discussed on page 392 of [5], pages 51-52 of [7] and page 49 of [3].

Although not as powerful as adding DC chokes in series with the DC supplies inside an equipment, it is nevertheless a useful technique when we are struggling to ensure that an upgrade to the motor drives in our plant room does not prevent our site from complying with G5/4-1 (see [56], [57], [58]), so that it is

still permitted to be connected to the national HV grid.

It is also a useful technique when struggling to prevent the motors in our Explosive Atmosphere areas from running so hot that they can ignite the flammable gasses or vapours present and cause fire/explosion that could kill many people and significantly harm our company's income for a year or three.

Series chokes cannot be expected to significantly reduce interharmonics at frequencies below 100Hz.

I am old enough to have cut my teeth on thermionic valve circuits (i.e. "vacuum tubes", for our readers across the Atlantic) in my teenage years. Valve (tube) rectifiers were always designed with a series choke between them and their unregulated voltage storage capacitors, because they could not handle the current peaks that would otherwise occur. These chokes would typically be about half the size of the equipment's mains step-up/down transformer.

I can still remember the thrill of replacing big hot valves (tubes) with little black epoxy blocks – the first silicon rectifiers – and how we immediately stopped using the series DC chokes, because they were big, heavy and expensive and the new silicon rectifiers would handle the peak currents without them. If only we had all kept using the series chokes, we would not now be having to control harmonic emissions!

5.2.7 Charge-pump switch-mode technique

Electronic engineers should refer to section 10.5 of [5]. This equipment-design technique is not appropriate for systems and installations engineers, and it works on both DM and CM harmonic currents.

5.2.8 'Active' PFC circuits

Electronic engineers should refer to section 10.6 of [5], which describes an equipment design technique that is not appropriate for systems and installations engineering. It suppresses both DM and CM harmonic currents.

5.2.9 Interleaved active PFC

This is an equipment design technique that uses two boost converters operating 180° out of phase with each other, so the ripple currents in their boost inductors – which, after passing through the bridge rectifier, result in harmonic currents in the mains supply – are (almost exactly) 180° out of phase, and so (mostly) cancel out in the mains input.

It used to be necessary to use discrete components for this, but now there are some PFC controllers available that have been specifically designed for this technique, including: UCC28070 and UCC 28060.

This is not a suitable technique for systems and installations engineering, and works on both DM and CM harmonic currents.

5.2.10 6-phase (or more) rectification

Electronic engineers should refer to section 10.7 of [5], which works for both DM and CM harmonic currents.

It is also an appropriate technique for systems and installations engineers who specify/purchase rectifiers separately from the power converters. The rectifiers provide a "DC Link" that is a common DC bus for a number of power converters, for example a single 10kW rectifier might power a DC Link that feeds a dozen or more 1kW motor drives. The relevant references for systems and installations are pages 58-60 of [7] and the small comment on page 21 of [3]).

Single-phase VSDs and VFDs suffer from emitting all of the odd-numbered mains harmonics, including triplens as mentioned earlier. On four wire systems (i.e. 3 phase + N) the triplens add arithmetically in the neutral conductor, and can cause significant problems with localised power quality and equipment operation.

However, three-phase (6-pulse) drives running from reasonably low-distortion mains supplies have very low levels of "triplen" harmonics, of which the most important are the 3rd and 9th. Losing the 3rd makes it significantly easier to use series inductors in the AC supply (see 5.2.6 above) to get good reductions in a rectifier's harmonic emissions.

Transformers with star and delta secondaries have a 60° phase-shift between their star and delta windings, so feeding two 3-phase bridges from each secondary and then linking their unregulated DC outputs creates a 6-phase (often called 12-pulse) rectifier.

12-pulse rectifiers have significantly reduced emissions of 5th and 7th harmonics, and their first significant emission of mains harmonics is the 11th.

So-called "Zig-Zag" transformers [59] can be used to create phase shifts other than 60°, allowing the creation of bridges with more than 12-pulses (6 phases). For example, a 24-pulse rectifier is created by using a mains transfer with windings giving 30° phase shifts, and four sets of 3-phase rectifiers feeding a common DC rail, and has significantly reduced emissions of 11th and 13th harmonics.

However, for the technique to be effective the requirement for well-balanced, low-distortion mains supplies increases as the pulse number of the rectifier increases. Vehicles, ships and offshore platforms often operate with their AC generators highly loaded by non-linear loads, and as a result often have severely distorted mains supplies, making it difficult to use this technique, but with appropriate filtering they can successfully use 12-phase (24-pulse) rectifiers – refer to the American Bureau of Shipping's guidance [60].

The DC choke method of 5.2.6 can be used to great effect with rectifiers having three or more phases. For a given harmonic attenuation it will generally be a lot smaller than would be needed for a single-phase rectifier of the same rating.

5.2.11 Active front end (AFE) rectification

Electronic engineers should refer to section 10.8 of [5]. This is not a technique that can be applied at the system/installation level, and it suppresses both DM and CM harmonic current emissions.

Some of the techniques described above have been used for many decades, but the "active front end" (AFE) technique, which uses IGBTs instead of plain old rectifiers, is a relatively recent development at the time of writing (September 2011).

The IGBTs are switched at a high rate, just like a chopper that drives PWM into a motor, but powerful signal processors and their controlling software arrange the sequencing and timing of their switching so that – after passing through a series inductor to average out the high-frequency PWM – the result is a rectifier that appears to the mains supply as a substantially linear (i.e. resistive) load. AFEs are claimed to be able to achieve low emissions of mains harmonics (< 5% I_{thd}).

However, AFEs achieve this at the cost of significant high-frequency harmonic currents in the supply at the switching frequency of the AFE bridge, higher EMI emissions between 10kHz and 100kHz, and a number of other EMC issues.

AFE rectifiers, being series devices, have to be dimensioned for the total load. This, of course, is a matter of equipment selection, and is not otherwise under the control of a system integrator or installer.

It is always great fun to read the various articles in the industrial press, in which the suppliers of motor drives and other products using AFE and the suppliers of other techniques for harmonic reduction, argue the toss over whose approach is better, or more cost-effective. Sometimes one can even learn something from such exchanges.

An interesting aspect of AFE technology is that it can also – with suitable IGBT gate switching patterns – provide bi-directional power transfer. For example if used in a motor drive it can transfer power from the motor back to the AC mains supply, i.e. regenerative braking.

I have worked on converters for solar photovoltaic panels that used such technology to add mains power to the PV power when the sun was not bright enough for the PV to supply the full load, which could also export power to the national grid when the solar power available exceeded the load's requirements.

5.2.12 Anti-harmonic injection, usually called "Active Filtering"

Electronic engineers should refer to section 10.9 of [5], and systems and installations engineers should see pages 54-55 of [7] and 50-51 of [3]. This technique is used to suppress DM harmonic emissions, but there seems to me to be no reason why it could not be used to suppress CM currents instead (or as well).

I call this an anti-harmonic injection technique, but the manufacturers of products intended for cleaning up harmonic pollution from mains distribution networks generally call them "active filters". This is despite the fact that neither the technique nor the products have anything at all to do with *actually filtering* the mains supply, see Figure 5.2-4.

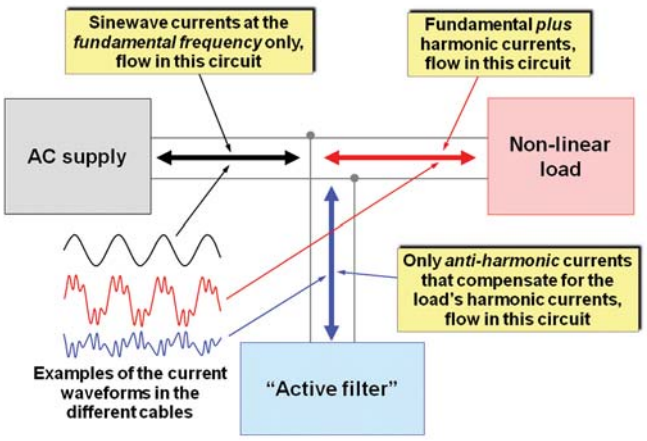

Figure 5.2-4 Principle of operation of so-called "active filters"

The technique uses switch-mode AC-AC power inverter technology, and can be applied in a way that makes it relatively immune to phase imbalance and distorted supply waveforms – so it acts on the emissions from an item of equipment and does not try to correct the entire mains distribution network it is connected to.

Active filters can be designed into products to reduce their harmonic emissions into their mains supplies, but are more commonly used to reduce the levels of harmonic currents (and hence the levels of harmonic voltage distortion) for systems and installations. For example, like passive harmonic filters, they can be applied to:

- A whole building or site, to reduce its harmonic emissions at its point of common connection to the MV or HV supply. (For example to help comply with the G5/4 requirements [56], [57], [58] for connection to the MV or HV grids in the UK. Other countries have similar harmonic requirements.)
- A whole building or site, to reduce the exposure of its MV or HV transformer to harmonic currents that would cause it to overheat (or else require costly over-rating).
- A whole vehicle, ship or offshore platform to reduce the exposure of its generator to harmonic currents that would cause it to overheat (or else require costly over-rating).
- A branch circuit (e.g. one floor of a tower block) to reduce the harmonic levels elsewhere in the mains feeder and other branches of an LV distribution network. (Has little/no effect on the harmonic distortion of that branch itself)
- A single item of equipment (typically a large machine or power converter) to keep its harmonics out of all of the LV distribution of its ship, platform, vehicle, building or site.

Active filters are expensive but widely used. Depending on the type, they can reduce emissions of harmonic voltage distortion to below 5%. They are connected in parallel with the mains supply and so only need to be rated for the harmonic current, unlike series-connected passive filters – which have to carry the whole of the load current (see 5.2.5 above).

5.2.13 Other techniques for systems and installations

If the above techniques don't provide enough harmonic reduction in a system or installation, or are impractical for some reason, we are left with the following techniques:

- Isolating an especially "noisy" or "sensitive" branch of the mains distribution by isolating and regenerating the mains power that supplies it, to remove all DM and CM harmonic currents.

- Isolating the mains power with a transformer that has a Delta winding for its primary and/or secondary, to remove DM triplens and all CM harmonic currents.

- Ignore harmonic suppression and simply uprate cables, transformers, motors, overcurrent protectors and other mains-powered components to be able to handle the distorted mains supply and/or harmonic currents without compromising reliability.

Isolation for a distribution network branch was traditionally achieved by using a motor-generator set, and many scientific survey vessels have used them to generate "clean" sinewave power for their sensitive instruments. These days an uninterruptible power supply (UPS) would most likely be used instead, but it must be an isolating continuous on-line double-conversion type.

Beware of M-G sets and UPSs that have such high emissions of harmonics that they make the problem worse, or create new problems due to their poor EMC, or are too unreliable.

The side of the M-G set or UPS that has to deal with highly-distorted mains must be appropriately rated for the harmonics, and up-rating is discussed last in this section.

Single-phase rectifiers generate triplen harmonics, which add constructively in 3-phase AC mains distribution systems, so in installations where most of the load is single-phase, the 3rd harmonic generally has the highest levels and causes the most overheating problems.

An example of this exact problem affecting a major road tunnel lighting scheme is given in Figures 11 and 12 of [7] and their associated text, and it is only one of the road tunnel lighting scheme harmonic problems that I have worked on over the last 21 years.

Passing the 3-phase through a star-delta transformer attenuates the DM triplen harmonics, and the better the balance of the triplens on the phases, the better the attenuation.

But the energy in the triplen harmonics circulates as a zero-phase flux in the transformer's Delta windings, so it is important to uprate the transformer so that it can handle the additional iron and related losses without overheating or otherwise compromising its reliability.

For legacy systems and installations, uprating is the costly option that we are left with when all else fails. However, for a new build it can sometimes be the easiest and most reliable method of dealing with harmonics, possibly even the lowest-cost (although it won't help you win any carbon credits).

Essentially, all we do is calculate the harmonic current loading on the various branches and the whole AC supply distribution network, then design our cabling, transformers, motors, overcurrent protectors and other mains-powered components to handle the additional heat generated by the harmonic currents and by the harmonically distorted mains supply voltage.

Pages 9, 19 and 20 of [7] provide some simple formulae for calculating how to uprate conductors and transformers.

But *never uprate overcurrent protection devices*, except when uprating everything else accordingly, see 5.2.14 below.

5.2.14 Overcurrent protection, safety, and the effects of harmonics

Although not an EMC issue, I feel that it is important to add a final note about overcurrent protectors, such as fuses and thermal and/or magnetic circuit breakers, because of the very significant safety issues that often arise with them as a result of harmonic current "pollution".

Electricians are often supplied with low-cost multimeters, which with the addition of current clamps can measure currents up to kA. It is often found with legacy installations that, as the old energy-inefficient plant is replaced by shiny new electronically-controlled plant, fuses and circuit breakers can start to open when measurements of the currents in the cables show that they are still within their current ratings.

The usual solution is to uprate the overcurrent protection, so we might find that a 100A cable carrying 100A of current (as measured with the low-cost multimeter and its current clamp) and protected by a 130A circuit breaker, because it only opens when the meter shows the current exceeds 100A.

The next thing that we find is that the cable insulation is starting to degrade through overheating, in certain places. If we are lucky we will discover this before we have a (possibly major) fire or explosion.

The problem is that the low-cost multimeters are average-responding types, calibrated as measuring RMS by using a pure sinewave. When measuring a real-life *impure* mains waveform, for example one that has significant levels of harmonic distortion, they can measure as much as 30% low, and so underestimate the real heating effect of a real-life voltage or current by nearly 70%.

These days, ***all*** electrical measurements on equipment, systems and installations ***must*** use true-RMS meters that have a frequency range of up to at least 2kHz (preferably 5kHz or more).

Thermal overcurrent protectors, whether they are fuses or circuit breakers, automatically respond perfectly correctly to any distorted current waveforms. But magnetic and other types of overcurrent protection will have trip responses that change with the level and type of distortion – unless they use electronic circuits that have a true-RMS response to at least 2kHz (preferably at least 5kHz).

So whenever we have problems because a thermal fuse or thermal circuit-breaker (or true-RMS electronic protector) is

opening when the current in the cable, transformer, motor or other equipment it is protecting appears to be lower than should be needed to open it – we must always believe the overcurrent protector and question why it is that we think the current is too low.

See pages 15 to 19, and 43-44 of [7] for more detail on this important reliability and safety issue.

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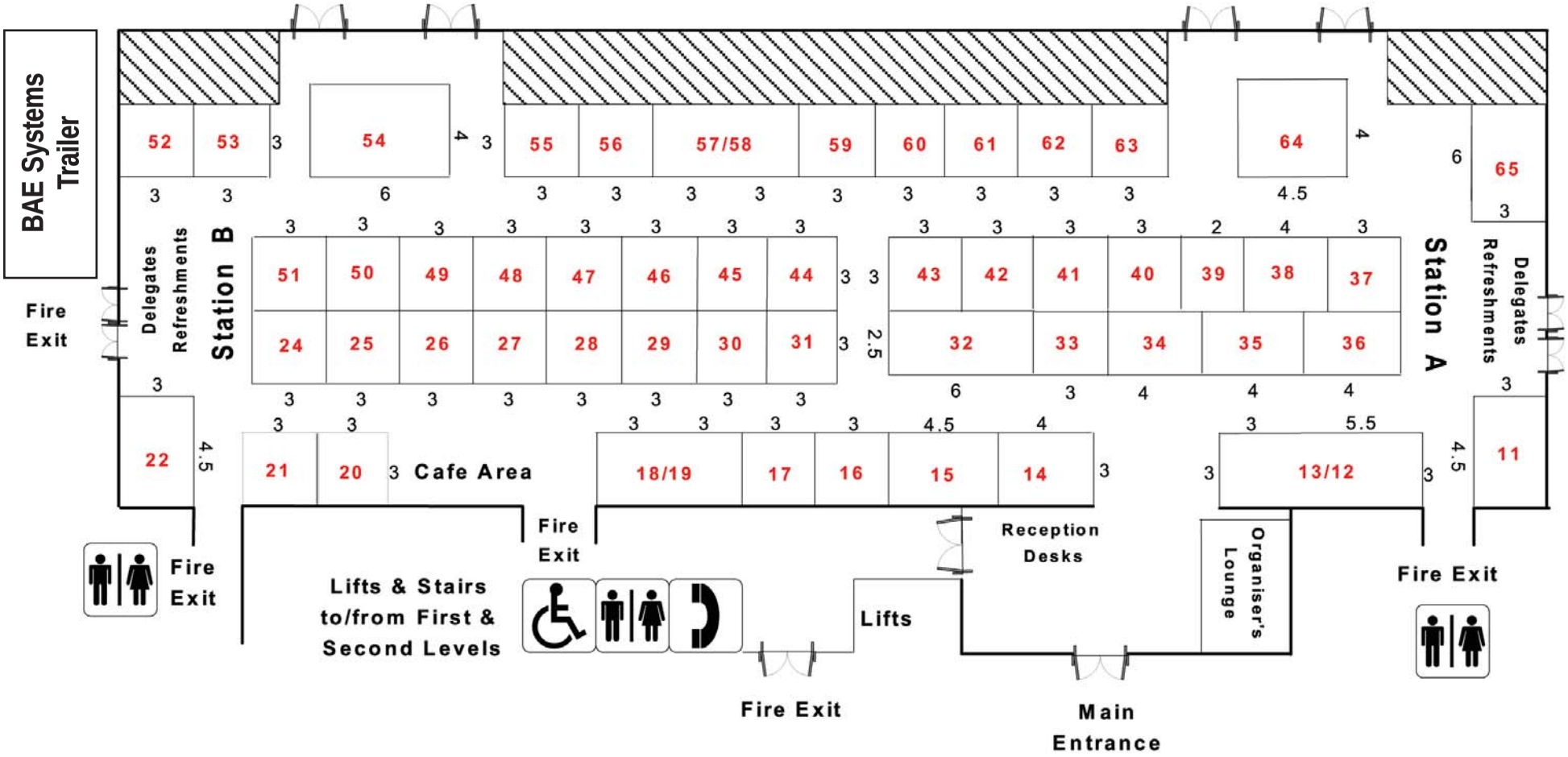
Siepel S.A.S. www.siepel.com	14
Syfer Technology Ltd www.syfer.com	36
Telonic Instruments Ltd www.telonic.co.uk	50
Teseq Ltd www.teseq.com	11
Tioga Ltd www.tioga.co.uk	47
TMD Technologies Ltd www.tmd.co.uk	15
TraC www.tracglobal.com	33
Trescal Ltd www.trescal.com	22
TÜV SÜD Product Service www.tuvps.co.uk	37
Ultra Electronics Test Solutions www.ultra-electrics.com/test_solutions.php	48
Uvox Ltd www.uvox.co.uk	59
Wurth Electronics UK Ltd www.we-online.com	54

Exhibition Floor Plan



Note: This is a location plan only and is not to scale. We reserve the right to make positional changes.

Electromagnetic Compatibility Technical Forum

Tuesday 11th October 2011

08.30 Registration

09.00-10.30 **EMC in Defence Systems**

Chairman
Ian MacDiarmid, *BAE Systems (Military Air Solutions)*

Modelling Versus Measurement in Maritime Platforms
Jonathan Burbage, *BAE Systems*

Cots Procurement for Military Systems
Ian MacDiarmid, *BAE Systems (Military Air Solutions)*

High E-Field EMC Testing in a Mini-Reverberation Chamber
Colin Lawrence, *MBDA UK Ltd*

10.30-11.00 Coffee & Visit to Exhibition Stands

11.00-12.30 Automated Comparison of EMC Datasets
Dr Chris Jones, *BAE Systems (Military Air Solutions)*

EMC & Functional Safety in Defence Standards
Peter Dorey, *TÜV SÜD Product Service Ltd*

EMC in Military Vehicles
TBC

12.30-14.00 Lunch & Visit to Exhibition Stands

14.00-15.30 **EMC in Buildings & Infrastructure**

Chairman
Keith Armstrong, *Cherry Clough Consultants*

Protection of Electronics and Installations
Dr Alexander van Deursen, *Department of Electrical Engineering - Electrical Energy Systems, Technical University of Eindhoven: TU/e*

High Power Electromagnetic (HPEM) Environments: Emerging Requirements and Standards for the Protection of Buildings and Infrastructure
Richard Hoad, *Electromagnetic and Environmental Services (EMES), QinetiQ*

Offshore Power Quality - A Case for Concern!
Ian C Evans, *Harmonic Solutions Co.Uk*

15.30-16.00 Tea & Visit to Exhibition Stands

15.00-17.30 EMC at ITER - the World's Largest Nuclear Fusion Generator
David Beltran, *ITER Organisation*

EMC for Theatres, Recording & Television Studios
Tony Waldron, *CADAC Holdings Ltd*

Modelling for the Protection of Facilities
Paul Duxbury, *CST UK Ltd*

17.30 Finish

Wednesday 12th October 2011

08.30 Registration

09.00-10.30 **EMC in Transport Systems (including: Electric Vehicles)**

Chairman
Steve Hayes, *TRaC EMC & Safety Ltd*

EMC in Railway Systems (Panel Session)

Achieving EMC for the Railway - Examples from Key Projects
Ken Webb, *Mott Macdonald*

EMC Analytical and Verification Techniques used in Signalling Systems
Stuart Charles, *E-mead Consulting Ltd*

EMC & Fixed Installation in Railway Systems
Damon High, *TÜV SÜD Product Service*

10.30-11.00 Coffee & Visit to Exhibition Stands

11.00-12.30 **EMC in Electric Vehicles & their Charging Systems** (Panel Session)

Hybrid Vehicle Specs & Testing, Vehicle Directive Update
Peter Phillips, *MIRA Ltd*

EU Developments in Electromobility
Steve Hayes, *TRaC*

Electric Drives in Transport
TBC, *BAE Systems*

12.30-14.00 Lunch & Visit to Exhibition Stands

14.00-15.30 **EMC in Consumer Electronics, including Diagnostics & Smart Grid/Metering**

Chairman
Paul Duxbury, *CST UK Ltd*

Smart Grid/Metering (Panel Session)

Smart Grid/Meters, an Overview for EMC Engineers
Simon Harrison, *Engage Consulting Ltd*

Existing Utility Infrastructures and Smart Grid Initiatives
Mark Buckland, *Echelon*

PPLT & Smart Grid
Richard Marshall, *Richard Marshall Ltd*

15.30-16.00 Tea & Visit to Exhibition Stands

16.00-17.30 Radio and EMC Compliance for Smart Grid and the Connected Home
Joe Lomako, *TRaC*

EMC in Testing & Diagnostics

Innovative EMI Diagnosis with New Real-Time Spectrum Analysis
Karl-Heinz Weidner, *Rohde & Schwarz UK Ltd*

Radiated Emission Measurements in an Open Area Test Site
Colville Crooks, *Agilent Technologies UK Ltd*

17.30 Finish

An EMC Academy Event

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EMC Training for Industry by Industry

Book Now

www.emcuk.co.uk/conference/

Just £155+VAT per day. Includes lunch, proceedings, coffee & tea breaks

EMC Training Programme

Tuesday 11th October 2011

08.30 Registration

09.00 – 10.30 **Tim Williams**
ELMAC Services Ltd

Theory and live demonstration of:

- Coupling between wires, showing common impedance, mutual inductance, mutual capacitance and the effect of shielding
- The effect of a slot in a ground plane: why you should avoid it
- Mutual coupling of wire pairs: from mains cable to high-quality coax, why running signal and return together is so important

10.30 – 11.00 Coffee & Visit to Exhibition Stands

11.00 – 12.30 **Keith Armstrong**
Cherry Clough Consultants

A live demonstration of how easy it is to use a home-made loop probe – perhaps made from a paper clip – with a spectrum analyser costing less than £1000, to quickly and easily diagnose common EMC problems, such as:

- slots and seams in enclosures causing problems for shielding
- inappropriate types of cables and connectors
- assembly details that can cause problems for filtering
- inadequate filtering causing radiated emission problems above 30MHz
- inadequate shielding causing conducted emission problems below 30MHz

12.30 – 14.00 Lunch & Visit to Exhibition Stands

14.00 – 15.30 **John Davies**
EMC Goggles Ltd

Visual training with practical demonstrations of:

- Understanding EMC. A sample of the EMC Goggles training course.
- The components are everywhere! See the invisible components and use them to your advantage.
- EMC design - emissions from PCBs. Live demonstration of Good versus Bad.
- After discovering an EMC failure in the lab, some tips and tricks on how to quickly diagnose the cause and also how to implement the solution.

15.30 – 16.00 Tea & Visit to Exhibition Stands

16.00 – 17.30 **John Davies**
EMC Goggles Ltd

Continuation of above.

An EMC Academy Event

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EMC Training for Industry by Industry

Book Now

www.emcuk.co.uk/conference/

Just £155+VAT per day. Includes lunch, proceedings, coffee & tea breaks

Wednesday 12th October 2011

08.30 Registration

09.00 – 10.30 **Tim Williams**
ELMAC Services Ltd

Theory and live demonstration of:

- Cable shielding and the effect of a pigtail versus a proper connection
- Self-resonance of components: the effect of parasitic inductance and capacitance, ferrite materials, and terminating impedance of filters, from SM to mains components
- Inductive coupling to a small loop: why scope probes don't always tell the truth

10.30 – 11.00 Coffee & Visit to Exhibition Stands

11.00 – 12.30 **Keith Armstrong**
Cherry Clough Consultants

Using quick, easy, low-cost close-field probing techniques to reduce financial risks in every stage of a new product's project:

- Proof of design principle
- Design, and component selection
- Development
- Fixing problems during compliance tests
- QA of EMC performance in serial manufacture
- Checking EMC effects of proposed design changes, component substitutions and software upgrades
- Helping ensure EMC of systems and installations
- Maintaining EMC despite maintenance, repair, upgrades, modifications, etc.

12.30 – 14.00 Lunch & Visit to Exhibition Stands

14.00 – 16.00 **Keith Armstrong, Tim Williams & John Davies**

Note!

The Three For All: Panel session with the audience, discussing any questions on EMC design, testing and compliance. As well as questions from the audience, we'll be batting around a few old chestnuts – which end of the cable screen to ground, where to connect the safety earth or split a ground plane, and so forth. If you have a particular issue (perhaps even your own pet chestnut) which you'd like to air in open session, please email: **emcuk2011@emcuk.co.uk**

The presenters:

- Tim Williams is with Elmac Services, offering advice and training in all aspects of EMC design and test. He is the author of EMC for Product Designers, now in its fourth edition.
- Keith Armstrong is with Cherry Clough Consultants, and has been fixing EMC problems, providing special assistance with EMC management and design, and teaching EMC and safety training courses worldwide, on everything from cellphone PCBs to complete synchrotrons and tokamaks, since 1990. He has recently written some books on EMC design techniques.
- John Davies has over 20 years of EMC testing experience, the last 7 years as Managing Director of Blackwood Labs. He has now formed EMC Goggles, a training and consultancy company.

Experiment Demonstrations

The Racecourse, Newbury 11/12 October 2011

Organised by the UKRI Chapter, the Experiment Demonstration session will be held on Stands 40 and 41.

Free to All

Experiment Demonstrations and Computer Solution Demonstrations
The practical hardware presentations are intended to demonstrate EMC concepts and principles, phenomena, effects, and measurement methods. The computer solutions presentations are intended to illustrate EMC modelling approaches and simulation methods through a series of interactive computer demonstrations. The presentations are table-top informal practical demonstrations that are similar to poster sessions, they are presented simultaneously and repeated continuously. This year's agenda will include new demonstrations plus some popular ones from previous years.

Agenda

Session time: 10 - 15:00. There will be different demonstrations each day and content will include:

Tuesday 11th October 2011

Cable resonance for Teenagers.
Presented by Richard Marshall, Richard Marshall Limited.
A reconstruction of a transmission line oscillator built by me as teenager - using a thermionic valve and a 300 ohm transmission line comprising two 9mm copper rods 90cms long. This circuit oscillates at the frequency at which the transmission line presents an appropriate impedance. The effect of varying the position of the shorting bar, and of removing it altogether, will be demonstrated. This visualisation of resonance can contribute to understanding of the EMC aspects of cables.

The effect of circuit impedance on field-coupled crosstalk.
Presented by Roy Ediss, Ediss Electric Ltd.
An experiment originally by Thomas Jerse, from Vol 1 of the IEEE EMC Soc Demonstration Manual.
To understand the effect of circuit impedance on the magnitude and type of field-coupled crosstalk.

Modeling the Coupling to Cables in a 3D Environment.
Presented by Paul Duxbury, CST UK.
In many applications, such as a lightning strike, as well as other EMC susceptibility and emission scenarios, it is necessary to include in the 3D model an accurate representation of the often complex cable bundles which can be both inside and outside of any shielding enclosure. Due to the large aspect ratio which can exist between the enclosures (typically meters) and the cross sections of the individual conductors in the cable (often millimeters), this can be a very challenging problem. This demonstration will show how correct modeling of the cable within the enclosure is critical in ensuring that an accurate answer is obtained.

Video presentations of:
EMC Aspects of Magnetic Field Coupling of Current Loops.
Jasper Goedbloed.
ESD and EMI in Printed Wiring Boards".
Douglas Smith.
Effects of Pulse Rise/Fall Time on Signal Spectra".
Clayton Paul.

Wednesday 12th October 2011

QP Detectors... the inside story.
Presented by David Mawdsley, Laplace Instruments Ltd.
The demo will show the waveforms that are seen at the detectors inside a receiver and what happens at the QP detector, where the effect of the rise and fall times specified by CISPR16 can be clearly observed. This has a significant impact on the measurement, especially with impulsive signals which are commonly seen during conducted emissions tests.

Decoupling/bypass capacitor characteristics.
Roy Ediss, Ediss Electric Ltd.
How to evaluate insertion loss, self-resonant frequency and parallel resonance of various capacitors using a spectrum analyser with tracking generator. A technique to determine the parasitic inductance associated with bypass capacitors using Time Domain Reflectometry (TDR) and Time Domain Transmission (TDT) will also be shown.

Video presentations of:
EMC Aspects of Magnetic Field Coupling of Current Loops.
Jasper Goedbloed.
ESD and EMI in Printed Wiring Boards".
Douglas Smith.
Effects of Pulse Rise/Fall Time on Signal Spectra".
Clayton Paul.

Alphabetical Exhibitor Listing

Stand 60
Agilent Technologies UK Ltd
610 Wharfedale Road
Winnersh Triangle
Wokingham, Berks RG41 5TP
Tel: +44 (0)118 927 6201
Fax: +44 (0)118 927 6855
contactcenter_uk@agilent.com
www.agilent.co.uk
Contact: Charlie Wheeler

Agilent Technologies, the global market leader in electronics will be showing from pre-compliance measurements and EMC diagnostic evaluation of your breadboard design to full compliance testing of your completed product that Agilent has the solution for all your measurement requirements.
Ensuring accurate and comprehensive evaluation of EMI compliance is an essential part of any successful design cycle. Agilent's compliance EMI receiver offers outstanding accuracy, affordability and full compliance with the CISPR 16-1-1 and MIL STD 461 standards.
Come and talk to the experts at stand 60 to discover how Agilent's EMI receiver solution can help you overcome your EMC challenges.
See also the new MXE X Series signal analyser.
Find out how Agilent can help you get your designs from concept to customer – faster!
For more information call 0118 927 6201 or visit **www.agilent.co.uk/find/emc**

Stand 49
ANSYS UK Ltd
First Floor, Unit 8
Bracknell Beeches
Old Bracknell Lanes West
Bracknell, Berks RG12 7BW
Tel: +44 (0)1344 767550
Fax +44 (0)1344 767551
ukinfo@ansys.com
www.ansys.com www.ansoft.com
Contact: Charles Blackwood

ANSYS Inc., is a leading developer of high-performance electronic design automation (EDA) software, used to design state-of-the-art electronic products. Owing to the complexities of today's high frequency and high-speed components, design re-spins can be commonplace and expensive, particularly with regard to EMC issues. The risk of design re-spins can be substantially reduced using the industry-standard electromagnetic software ANSYS HFSS™. HFSS is widely used for analysing full 3D field behaviour, and extracting S-parameter and full-wave SPICE models.
For very complicated full board and package structures ANSYS Ansoft SIwave allows similar extraction capabilities. The coupling of SIwave and HFSS allows full EMC analysis of a complete complex package / PCB and its housing.
ANSYS tools include ANSYS Icepak® technology providing robust and powerful fluid dynamics software for electronics thermal management.
Ansoft tools can improve engineering productivity, reduce development time and better assure first-pass design success.

Stand 30
AQL EMC Ltd
16 Cobham Road
Ferndown Industrial Estate
Wimborne, Dorset BH21 7PG
Tel: +44 (0)1202 861175
Fax: +44 (0)1202 861176
lee.beale@aqlemc.co.uk
www.aqlemc.co.uk
Contact: Lee Beale

AQL EMC Ltd is a longest established UKAS accredited and DCSA approved test laboratory specialising in all types of Defence and Aerospace EMC including Lightning, HIRF and EMP testing. As acknowledged experts in Defence and Aerospace testing and consultancy, we regularly test to many standards including Def Stan 59-411, EFA, Bowman, Panavia, Mil Std 461A/B/C/D/E/F, RTCA/DO-160C/D/E/F (Sections 15 to 22 inclusive) in our 7 state-of-the-art test chambers.
A major expansion programme, includes two large additional chambers for vehicles/complex system tests, plus a reverberation chamber for high field-testing (10kHz-40GHz), Mil Std 464A tests (22kV/m), RS105 & 50kVA 0-600V 45Hz-800Hz variable frequency supply. This has established AQL EMC as the market leader in all aspects of EMC, EMP, HIRF and HERO/RADHAZ testing and consultancy.
We can offer a personal service in a truly flexible and responsive manner, either at our well-equipped laboratory on the south coast or at any location worldwide.

Stand 65
AR UK Ltd
Unit 8 Madingley Court
Chippenham Drive, Kingston
Milton Keynes MK10 0BZ
Tel: +44 (0)1908 282766
Fax: +44 (0)1908 288249
sales@uk-ar.co.uk
www.uk-ar.co.uk
Contact: Mark Reeve

AR UK will be showcasing new products at EMC UK including the latest 'A' Series 10kHz-400MHz amplifiers. The 200W or 350W models incorporate the latest technology providing class leading efficiency and distortion. Also appearing will be our new dual band solid state microwave amplifiers covering 1 – 18GHz. Other products to feature are the lighter and smaller 2.5kW to 16kW solid state amplifiers, plus the completely automated radiated Immunity test systems.
Also ''Why pay for software?'' AR continues to give away free copies of our SW1007 software to qualified customers.
New to our range is Montena EMC a leading specialist in the design and manufacture of HEMP, LEMP and High Power Transient Test systems for MIL and DEF Standards.
AR Europe recently formed a strategic partnership with ETS-Lindgren providing turnkey systems tailored to your specific needs. AR UK can manage the project from design to commissioning and after sales support.
Remember our first class lifetime support of all our products is legendary. AR UK has fully equipped service facilities where we support our UK, European and Middle East customers and AR Europe distributor network.
Our staff will be at the show to answer any questions about these and all our products.

Mobile Trailer
BAE Systems
W391, Warton Aerodrome
Warton, Preston
Lancs PR4 1AX
Tel: +44 (0)1772 855568
Fax: +44 (0)1772 855250
damian.austin@baesystems.com
www.baesystems.com
Contact: Damian Austin

BAE Systems
Faraday Test Centre
Airport Works
Rochester
Kent ME1 2XX
Tel: +44 (0)1634 204457
Fax: +44 (0)1634 203647
paul.j.davison@baesystems.com
www.baesystems.com/faradaytestcentre
Contact: Paul Davison

BAE Systems at its Warton and Rochester sites provides solutions to an immense range of EMC and Environmental design and test requirements. The expert teams cover a wide range of capabilities spanning civil and military markets and air, land and naval platforms. Specialist areas are Electromagnetic Engineering (EME), Electronic Warfare, Computational Electromagnetics, Structural test, Wind Tunnels, Simulation, & Synthetic Environments & Flight Test Support. Electromagnetic Engineering provides recognised knowledge and skill capabilities in all aspects of the electromagnetic behaviour of vehicles, platforms, systems and components. This includes design, simulation, test and certification in the areas of Low Observability, Electronic Warfare, Installed Antenna Performance and Electromagnetic Hazard Protection. Electromagnetic Engineering supports all projects at any stage of their design, development, production and support lifecycle through the development and provision of its engineers and facilities. The test lab capabilities and services at the Faraday Test Centre, Kent, include fully equipped Environmental and EMC test labs, CE/Low Voltage Assessments, test plans, test procedures, test reports, cable and fixture design and design consultancy. The Faraday Test Centre is a United Kingdom Accreditation Service (UKAS) test laboratory, accredited to ISO 17025 for Environmental and EMC testing (UKAS registration number 0047). It also is ISO 9001 approved by BAE Systems Quality Management System.

Stand 55
Blackwood Compliance Laboratories
Unit 8
Woodfieldside Business Park
Pontllanfraith, Blackwood
NP12 2DG
Tel: +44 (0)1495 229219
Fax: +44 (0)1495 228331
pgwilliam@blackwood-labs.co.uk
www.blackwood-labs.co.uk
Contact: Paul Gwilliam

Blackwood Compliance Laboratories provides UKAS accredited Electrical Safety, EMC and EMF testing from its purpose built facilities in South Wales. Now part of the Kiwa group, Blackwood are specialists in finding solutions to your products problems during the development phase. Blackwood remain a Notified Body under the EMC directive and continue to expand the range of standards covered within the scope of its accreditation.
Blackwood has established an enviable level of quality and customer service; evidenced by levels of repeat business. The vast majority of test reports are issued within three days of the completion of testing.
As part of the Kiwa group, Blackwood Labs has access to significant and wide ranging facilities and technical support across Europe and into China.
Blackwood Compliance Laboratories;
Product testing you can trust
Member of EMCIA.

Stand 34
Castle Microwave Ltd
5 The Pentangle
Park Street
Newbury
Berks RG14 1EA
Tel: +44 (0)1635 271300
Fax: +44 (0)1635 271301
sales@castlemicrowave.com
www.castlemicrowave.com
Contact: Hazel Doughty

At Castle Microwave, we are celebrating our 30th anniversary this year as one of the foremost supplier of RF/microwave and optical products.
Our team can offer a unique understanding of your needs, from initial concept to production. With expertise covering components, subsystems and systems used in today's consumer, industrial, smart energy and telecommunication markets through to high end military, space-flight and optical markets.
For EMC and compliance testing, we offer radiation and field meters, power analysis including harmonics and flicker, noise analysis and intermodulation distortion equipments, through to screened and anechoic rooms using the most advanced ceramic and pyramidal absorbers and complimented by an extensive range positioning systems and antennas from electric and magnetic dipoles, conical/bi-conical and wideband horns.
The company is ISO9001:2008 certified and has a modern well equipped applications lab up to 50GHz providing engineering support, calibration and repair services.
Castle Microwave are your true long term partner.

Stand 31
CST UK Ltd
Strelley Hall, Main Street
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Fax: +44 115 906 1115
info@uk.cst.com
www.cst.com
Contact: Mohan Jayawardene

CST develops and markets software for the simulation of electromagnetic fields. Its products allow you to characterize, design and optimize electromagnetic devices all before going into the lab or measurement chamber. This can help save substantial costs especially for new or cutting edge products, reduce design risk, and improve overall performance and profitability.
Its success is based on the implementation of leading edge technology in a user-friendly interface. The extensive range of tools integrated in CST STUDIO SUITE™ enables numerous applications to be analyzed without leaving the familiar CST design environment and can offer additional security through cross verification.
CST's customers operate in industries as diverse as Telecommunications, Defense, Automotive, Electronics, and Medical Equipment, and include market leaders such as IBM, Intel, Mitsubishi, Samsung, and Siemens. CST markets its products worldwide through a network of distribution and support centers which also provide customer support and training.

Stand 29
Dexter Magnetic Technologies Europe Ltd
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Tel: +44 (0)118 960 2430
Fax: +44 (0)118 960 2431
amorris@dextermag.com
www.dextermag.com
Contact: Adrian Morris

Dexter Magnetic Technologies Europe Ltd continues to offer a market leading range of Soft Magnetic components for both existing and evolving customer applications in the EMI Suppression, Power and RFID market demands.
We pride ourselves in representing the most comprehensive range of products from Global brands and technology leaders in the domain of Ferrite, Powder and Amorphous based components and associated accessories. Technically competent engineers are available to discuss your requirements and provide the most cost effective solutions.
These companies include Fair-Rite Products Corp, Magnetics Inc, Ferronics Inc, Toshiba, Miles-Platts and the EPC-TDK group which emerged from the combination of the electronic components business of TDK and the EPCOS organizations.
Dexter Europe fully supports all of the above products with a dedicated warehouse facility in the UK and extensive inventory, providing customers a complete portfolio of soft magnetic products unmatched in European marketplace.
Dexter Magnetic Technologies is an industry leader of magnetic solutions and systems to the electronics, industrial, medical, data storage, semi-conductor and oil & gas markets. The group has offices and manufacturing operations in North America, Europe and Asia.

Stand 20
DM Systems and Test Ltd
60 Wilbury Way
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Fax: +44 (0)1462 428995
graham.howard@dplusm.co.uk
www.dplusm.co.uk
Contact: Graham Howard

Previously operating as a division of Dowding & Mills Calibration at Hitchin DM Systems & Test Ltd offer a range of equipment for use in compliance and HIRF testing, these include **High Power RF Amplifiers** from **IFI**, T**ransient Generators, LISNs & Current Probes** from **Solar** and **Fibre Optic Data and Communications Equipment** from **Versitron**. As an independent UK owned Company DM Systems & Test are able to offer comprehensive support services both in the field and in our own workshops for the these and a wide range of equipment from other manufacturers.

Stand 25
Electronic Test & Calibration Ltd
Caddsdown Industrial Park
Clovelly Road
Bideford
Devon EX39 3DX
Tel: +44 (0)1237 423388
sarahwm@etcal.co.uk
www.etcal.co.uk
Contact: Sarah Wragge-Morley

ETC Ltd is UKAS Accredited for EMC Testing and for Calibration.

EMC Testing
Military EMC Testing – *NEW Extended UKAS Accreditation* - MIL STD 461 D, E & F and DEF STAN 59-411: Part 3. Currently the only lab to have UKAS accreditation to the New NATO Standard AECTP-500 (Ed4)
Industrial & Domestic EMC Testing – UKAS Accredited Facilities to European Standards.

Calibration
Antenna Calibration – *NEW Extended UKAS Accreditation* - Bilog, Biconical and Ridged Horn Antenna Calibration now up to 18 GHz. Also Normalised Site Attenuation.
EMC Equipment Calibration – UKAS Accredited Calibration facilities for full range of EMC Equipment including Antennas.
Electronic Equipment Calibration - UKAS Accredited Calibration facilities for the full range of electronic test equipment from DC to RF.
Visit us at Stand 25 - for more information see **www.etcal.co.uk** or contact us on 01237 423388.

Stand 44
EMC Hire Ltd
Unit 1 Ivel Road
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Beds SG17 5JU
Tel: +44 (0)1462 817111
Fax: +44 (0)1462 819564
info@emchire.co.uk
www.emchire.co.uk
Contact: John Wombwell

A small but very well established company specialising not only in a vast range of EMC items for rental but in supplying bespoke systems with units tailored to customers exact requirements. These can then be automated with our laptops using software developed in-house during the last 15 years. Laptops come configured ready to switch on and run.
Site & Chamber Evaluation again well established in providing NSA both "free Space" & over a groundplane along with Field Uniformity measurements.
Shielding tests for chambers & vehicles, either spot or swept from **1kHz** up to **40GHz**.

Stand 43
EMC Partner (UK) Ltd
1A Golf Link Villas
Downley Common
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Bucks HP13 5YH
Tel: +44 (0)1494 444255
Fax: +44 (0)1494 444277
sales@emcpartner.co.uk
www.emcpartner.co.uk
Contact: David Castle

Geared to your compliance, EMC Partner is the authorised UK representative for leading manufacturers: EMC Partner, AFJ International, Frankonia, OPHIR and Schwarzbeck.
Our compliant product range includes the all new Transient 3000, ESD3000 & Harmonics 1000 Test Systems; All new digital EMI Receivers; Click Analysers CL55; Injection Clamps; High Voltage Impulse Generators; Antennas; Amplifiers; Anechoic Chambers; Meters; Probes and Shielded EMC Cameras.
Specialist solutions include, indirect lightning generators - providing full threat solutions in accordance with DO-160, MIL461, Airbus and Boeing specifications.
High quality test equipment, UKAS calibrations, Flexible and Efficient services gear EMC Partner to your compliance.

Stand 46
EMCIA
(EMC Industry Association)
Secretariat: Nutwood UK Ltd
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Bodmin, Cornwall PL30 4NQ
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Fax: +44 (0)1208 851630
emcia@emcia.org
www.emcia.org
Contact: Alan Warner

The EMCIA was formed in 2002 for the benefit of companies and organisations involved in Supplying, Designing, Testing and Manufacturing EMC products and services.
EMCIA is friendly trade association that's all about Networking, keeping you informed, providing marketing & promotional opportunities and hopefully assisting you to increase sales.
Our Networking lunches are normally preceded by interesting but short presentations on relevant topics. Lunches take place three times per year, normally in London, and provide an excellent forum to discuss the market and keep up to date with what's happening within the world of EMC.
The annual fee is £500. All companies large and small pay the same fee.
Our web site provides a platform for members to promote their products, new brochures, application notes and news stories. A new active promotion programme will ensure the site attracts maximum high quality visitors.
Members Press Releases will also be published FREE in a special section of "The EMC Journal" and on its web site. This alone should easily justify the annual membership fee.

Stand 28
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Fax: +44 (0)1438 730750
info@ets-lindgren.com
www.ets-lindgren.com
Contact: Ken Foan

UK & Ireland Distributor:
MDL Technologies Limited
Unit 11
Devonshire Business Centre
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Herts SG6 1GJ
Tel: +44 (0)1462 431981
Fax: +44 (0)560 315 2515
sales@mdltechnologies.co.uk
www.mdltechnologies.co.uk
Contact: Mark Lucock

ETS-Lindgren is renowned worldwide for EMC, RFI and EMI test solutions. With over 750 employees worldwide we manufacture and supply a wide range of shielded enclosures, anechoic chambers, RF filters, Absorber, Antennas, Field Probes, Positioners, Systems, etc, for industrial, government, defense and medical applications.
MDL Technologies Limited is the UK & Ireland distributor for ETS-Lindgren providing consultancy, sales distribution on all product lines, project management, installation and RF shielding expertise. In addition we represent MILMEGA with their RF & Microwave Solid State Broad Band Amplifiers and Chroma ATE with Power Electronic and Electrical Safety Test Equipment.
Product Sectors Covered:
Absorbers
RF & Microwave Amplifiers
Anechoic Chambers
Anechoic Materials
Antennas
GTEM Cells
RF / EMI Filters
RF / EMC Field Probes
Rad Haz Monitoring
Current Probes
EMC & Wireless Test Systems
RF Test Services
RF Shielded Rooms & Accessories
Shielded CCTV Camera Systems
Line Impedance Stabilisation Networks (LISNS)
Positioner Systems - Turntables, Masts
TILE EMC Control Software

Stand 14
Frequensys Ltd
Northern Office:
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Tel: 01142 353507
Fax: 01234 780133
Mob: 07785 956506
info@frequensys.co.uk
www.frequensys.co.uk
Contact: Simon Young

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Fax: +33 2 97 55 84 55
contact@siepel.com
www.siepel.com
Contact: Stephanie Jegat

Frequensys provide test equipments and full turn-key EMC test solutions. Our partners include Siepel, EM Test (ESD, Transients, Conducted Immunity, Harmonics and Flicker, AC Programmable Sources), Prana (RF Power Amplifiers - 10kHz to 6GHz), DARE (Field Probes and System Integration) and suppliers of EMC Accessories (CDN's, Current/BCI probes, LISN's, Antennas). We also provide specialist test solutions such as HIRF.
2011 has been a very successful year with our partner SIEPEL who are a major European manufacturer of Shielded Rooms and Anechoic Chambers and world leaders in providing solutions for EMC, Microwave, Data Processing Safety, Compact Ranges and Radio Communications test systems. They are active in all sectors providing compliant solutions to EN/ISO/CISPR/MIL-STD/ANSI/IEEE/ETSI/DO & DEF-STAN. Their product range includes; Anechoic and Shielded Rooms, Reverberation Chambers, Shielded Doors, Maintenance, Shielded Cabinets, Positioning Systems and EMC Automation. Their Absorber solutions are Broadband Pyramidal, Hybrid, Multilayer, Silicon and Flat Absorbers with the option of their unique soft plastic paint finish.

Stand 24
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info@globalemc.co.uk
www.globalemc.co.uk
Contact:Garry Pitchford

Global EMC will be illustrating anechoic materials and anechoic shielded chambers.

Available anechoic absorber types are:

- Pyramidal absorber capable of up to -60dB return loss
- Wedge absorbers for augmented low frequency performance
- Ferrite tile
- Special hybrid absorbers for use over ferrite tile
- Block absorbers
- High power absorbers

Anechoic chamber types are:

- EMC testing to CISPR16 and EN61000.4.3 (3m, 5m, and 10m separation)
- Vehicle test chambers (with engine cooling & fume extraction systems)
- Antenna measurement chambers
- W LAN test chambers
- Shielded cabinets and anechoic cabinets

Global EMC have a high capability to re-site/modify/upgrade existing shielded and anechoic chambers meeting customer specifications.
The new range of CCTV systems will also be shown and can be seen working via fibre optic links

Stand 64
HITEK Electronic Materials Ltd
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Fax: +44 (0)1724 280586
sales@hitek-ltd.co.uk
www.hitek-ltd.co.uk
Contact: John Terry

Following on from its accreditation to AS9100, the highest Quality Standard for Defence and Aerospace industries, and its approval to the Qualified Products List (QPL) of the Mil-DTL 83528 specification for Conductive Elastomer Gaskets, HITEK Electronic Materials Ltd is able to meet all the necessary demands and requirements of its customers.
With extensive stocks, a highly skilled workforce and a positive can-do attitude it is the leading source of Chomerics and Tecknit product in the UK. HITEK Electronic Materials is also heavily involved in SC21 and is working with over 45 SC21 registered companies and is aiming to achieve Bronze status early in 2012, a further commitment to providing the quality and delivery demanded by clients.
From electrically and thermally conductive gaskets, adhesives and resins, through radar absorbing materials (RAM), to materials for preventing galvanic corrosion, HITEK has the ability to provide premier customer service.

Stand 63
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www.httuk.co.uk
Contact: Roland Brunisholz

HTT (UK) LTD is the British Isles representative of Haefely Test AG and distributes their products in this region.
Haefely is a Swiss manufacturer of conducted immunity test systems reputed for the built quality and reliability of their products which find applications in CE marking, Telecom testing, Component testing, Railways applications, etc. Haefely is also one of the few manufacturers of NEMP systems and have delivered complete systems with charging voltage levels in excess of 600 kV For more information regarding news and products, please visit the Haefely EMC website: **http:// www.haefelyemc.com/**
This line of systems is complemented, on a distributor basis, by specialized equipment for military and avionics applications such as electromagnetic shielding meters, field measuring probes, filters and application specific solutions engineered by Thales DIS.

Stand 17
Hursley EMC Services Ltd
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sales@hursley-emc.co.uk
www.hursley-emc.co.uk
Contact: Julian Jones

Hursley EMC Services can provide valid certification for virtually any country. We are the UK's leading independent IT EMC laboratory, with UKAS accreditation to ISO 17025 as well as full affiliation under the NEMKO ELA programme and independent listings with VCCI , FCC , C-Tick, SABS/SANS, BSMI and MIC.
We have two 10 metre anechoic chambers and a formally accredited Open Area Test Site (OATS) with a 5 metre, 2 tonne turntable. We can also perform EMC tests on customers' premises and have specialised equipment for undertaking RF surveys for the Construction and Premises Management industries.
We are particularly strong in Far Eastern markets, being the only independent European EMC UK lab to have Taiwan's BSMI accreditation. We have also set up an on-site MIC certification scheme for our customers to export product to the Korean market place. We are also now accredited for testing to the new EMC requirements for Vietnam.
With customers requesting assistance with Military EMC testing, we have recently added DEFSTAN 59-41, 59-411 , MIL 461 and RTCA DO160 to our UKAS accreditation.
In addition to testing, we also provide EMC consultancy and training courses in all aspects of EMC testing and regulations.

Stand 62
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www.hypertac.com
Contact: Bill Henderson

Hypertac is a world leading provider of high performance electrical connectors and interconnect solutions for the most demanding applications. We combine the superior Hyperboloid socket contact technology with EMI Filtered and Transient Protection Technologies offering unrivalled performance in harsh environments e.g. those encountered in defence applications. With a wide variety of EMI filter technologies available combined with the leading transient protection technologies available within our sister organization, the Protection Technology Group, Hypertac are able to offer Filtering and Transient Protection for all applications, including primary lightning strike energy level protection. Our rapid prototyping and pre-production capabilities enable us to respond quickly and accurately to customer needs and provide them with the most reliable interconnect solutions within the market today.

Stand 61
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Contact: Rad Fismistr

Instrument Plastics Limited are one of the world's leading designers and manufacturers of high quality Optical Filters and Shielded Windows for electronic displays, specialising in the manufacture of custom-made EMI / RFI Shielded and Contrast Enhancement Filter Windows for a wide range of Instrument Displays.
Instrument Plastics Limited cast Optolite™ clear HSR (High Scratch Resistance) material in-house and fabricates filters to customers' requirements. Our offering includes cutting, machining, shaping, silk-screening, bespoke thicknesses/tight tolerances and colour matching.
Optolite™ has up to 20 times the scratch resistance of acrylic, combined with optical properties similar to Crown Glass. It is also virtually immune to most common chemicals, some nerve agents and can operate at temperatures up to 100°C.
Optolite™ shielded filter windows combine a high level of electromagnetic shielding with excellent contrast enhancement.
Visit our website at **www.instrumentplastics.co.uk,** where technical product information can be downloaded.

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michaell@io-electronics.com
www.io-electronics.com
Contact: Michael Leggett

IO Electronics provides a total manufacturing solution for your electronic assembly requirements. All products are built within a total quality environment, by highly experienced personnel utilising the latest automated manufacturing equipment.
Formed in 2002, we currently operate from our privately owned facilities of some 12,000 square feet manufacturing and administration space.
We offer:
- PCB Assembly
- Prototype Manufacturing
- Cable and Harness Assembly
- Cabinet Assembly
- Turnkey Manufacturing
- Programming, Test & Repair
- Potting 7 Conformal Coating
- Global EMC component sourcing

We deal with both horizontal and vertical markets, from international customers to local businesses who fall into many industry sectors, some of which include:
- Defence
- Aerospace
- Industrial Control
- Petrochemical
- Automotive
- Marine
- Healthcare
- Communications

With accreditations including:
BS.EN.ISO9002:2008
BS.EN.ISO14001:2004
BS.OHSAS18001:2007
we aim to deliver seamless, global electronic manufacturing services.

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kw@kemtron.co.uk
www.kemtron.co.uk
Contact: Kevin Worthington

Kemtron the UK's leading manufacturer of EMI/RFI shielding gaskets and component's, helps customers meet their EMC shielding and environmental sealing requirements with innovative solutions that enhance product performance, reduce through life costs and ensure regulatory conformance.
We have achieved a global reputation for quality, performance and reliability, with an enviable track record in demanding industries such as defence, aerospace, information technology, communications and electronics.
Kemtron has provided a specialist service in EMC solutions for over 30 years and has developed unparalleled experience and expertise in design, manufacture and support. By working in partnership with customers from an early stage, we help them optimise their shielding programmes while concentrating on their core business.

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www.fclane.com
Contact: Simon Hammerton

Lane Electronics is a franchised distributor and/or stockist for many leading connector manufacturers including Huber & Suhner, Souriau, Positronics, ITW McMurdo, ITW Pancon, Polamco, Glenair, Binder and military connector manufacturer Weald Electronics.
Along With IECQ – CECC, BS9000, ISO and QPL approvals, Lane has a policy of stocking Military and industrial circular and rectangular connectors including coaxial, MIL-DTL-38999, MIL-C-26482, Fibre, Data, and D types.
In addition to standard connectors, Lane can offer a full range of Huber+Suhner Test and Measurement leads, microwave cables, adaptors and test kits. Lane can also provide military style RFI Filter connectors and 360 Deg EMC screen termination solutions from Weald Electronics and Polamco.
www.fclane.com

Stand 35
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tech@laplace.co.uk
www.laplace.co.uk
Contact: David Mawdsley

Our stand will feature complete systems for RF emissions and RF immunity testing, both conducted and radiated. These will be fully operational for the duration so that visitors can obtain first hand experience of the ease of use and benefits of the Laplace systems.
Tests covered include:

- Radiated emissions
- Conducted emissions
- Radiated RF Immunity
- Conducted RF immunity
- Harmonics and Flicker
- ESD

Equipment includes:

- EMC analysers
- Pre-selectors
- Test Cells
- LISNs
- Antennas
- Voltage probes
- Synthesisers
- Power amplifiers
- CDNs
- Near field probes

A key aspect we offer to all our customers is support, both software and technical, plus an intensive training course, entirely practical and pragmatic, so that even those with no previous experience can start testing with confidence.
Whatever your EMC test requirements, talk to our experienced engineers on our stand for advice and no-nonsense discussion.

Stand 51
Mariner Systems Test Laboratory
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Tel: +44 (0)1325 321366
info@mstesting.co.uk
www.mstesting.co.uk
Contact: Stephen Thompson

Located in County Durham, Mariner Systems is a UKAS accredited test laboratory. Experts in marine type approval testing and consultancy. Specialists in EMC, Vibration and Climatic testing. Substantial investment in a new location, anechoic chamber and integrated test systems enable us to provide market leading turnaround and levels of service coupled with the highest levels of accuracy and repeatability.

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peter.gordge@mbda-systems.com
www.mbdaps.com
Contact: Peter Gordge

"The EMC team at MBDA specialises in meeting relatively severe defence-related EMC requirements for both bespoke defence equipment and Commercial -Off The-Shelf (COTS) items. In support of this mission the team operates a comprehensive range of EMC chambers and ancillary facilities in purpose-built premises at its Filton base near Bristol. These include two large anechoic chambers (L x W x H: 10.5m x 5.5m x 4.6m & 9.7m x 3.2m x 4.3m) and a complementary pair of reverberation chambers, one large and one small (L x W x H: 8.4m x 4.2m x 5m & 1.29m x 1.10m x 0.92m), capable of being configured for either mode-tuned or mode-stirred operation. The MBDA team is particularly pleased to be presenting a paper on high E-field testing in the smaller reverberation chamber (at around 10kV/m) in the Technical Forum of EMC UK at 10:00 on Tuesday 11th October. MBDA also offers modelling support, applying codes such as CST Microstripes for 3D electromagnetic simulations and ORCAD for circuit design of EMC filtering solutions. Customers typically discover and appreciate that the MBDA team is especially adept at helping them to meet severe defence EMC specifications, which are becoming an increasingly prominent requirement in the modern battlespace.

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Contact: Mark Lucock

MDL Technologies Limited is an independent company representing a number of leading global manufacturers (ETS-Lindgren, MILMEGA, Chroma ATE Inc.) distributing electronic test equipment and facilities across the UK and Ireland. We provide specialist sales, consultancy, calibration & systems capability along with project management, installation and RF testing of shielded rooms and anechoic chambers.
Manufacturers :
ETS-Lindgren is renowned worldwide for EMC, RFI and EMI test solutions. With over 750 employees worldwide they manufacture a wide range of RF shielded enclosures, anechoic chambers, RF filters, Absorber, Antennas, Field Probes, GTEM's, Positioners & Wireless / EMC Test Systems, for industrial, government, defence and medical applications.
MILMEGA is a leading specialist in the design & manufacture of RF / Microwave Solid State Broad Band Amplifiers. Based in the UK the modular architecture amplifiers provide impressive broadband frequency and power coverage for EMC applications from 80MHz to 8GHz. MILMEGA have recently launched their new range of modular 80MHz to 1GHz RF amplifiers with upgradeable power from 175W to 1kW and we will be showcasing these at the conference.
Chroma ATE Inc. is a world leader in the electronic test and measurement industry providing test solutions amongst others for:
Power Supply Testing: Programmable AC / DC Power Sources, Programmable AC / DC Electronic Loads, Power Analyzer & Digital Power Meter, Power Supply ATS.
Electrical Safety Testing: Multi-function Electrical Safety Analyzers, Hipot Testers, Ground Bond Testers, Electrical Safety Test Scanner, EST Meter/Calibrator, Electrical Equipment ATS, Medical Electrical Safety ATS.

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www.metecc.eu
Contact: Peter Metcalfe

METECC for EMC and LVD Testing, Training and Consultancy
METECC offer a wide range of testing to Standards for most domestic and professional equipment, including MIL SPEC 461 and DEF STAN 59-41.

- EMC testing in our purpose-built anechoic chamber
- EMC testing on your site or at the fixed installation
- EMC and LVD training and consultancy
- LVD assessments
- EMC design and development

All with personal service and at competitive prices.
Our mobile testing suite brings you cost-effective testing "on-site". Any place! Any time!
Our professional team can see your project through from initial design to production release.

- Peter has forty years of RF engineering and lecturing experience.
- Sharon, a physics graduate, brings over thirty years lecturing experience.
- Emphasis on personal service.
- Pay only for the time that you use.

Call at Stand 57/58 to discuss how METECC can help you.

Demonstration by METECC:
LED Lighting – the next PLT?

- Are there hidden problems with certain LED lamps?
- Do LED lamps conform to the Essential Protection Requirements of the EMC Directive?
- See for yourself the surprising results when we emissions tested a range of LED lamps.

Visit METECC's demonstration on Stand 57/58.
Contact: Peter and Sharon Metcalfe on 077250 79956. www.metecc.eu

Stands 18 & 19
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joeley@milmega.co.uk
www.milmega.co.uk
Contact: Joeley Messer

MILMEGA, the premier European Designer and Manufacturer of high power microwave and RF amplifiers. At EMCUK 2011, **MILMEGA** will be exhibiting their new 80MHz to 1GHz range of amplifiers, with powers levels from 175W up to 1kW **MILMEGA** customers benefit from the security of guaranteed minimum specifications and comprehensive choice of amplifiers matched to common band breaks.
The **MILMEGA** CSA architecture delivers superior harmonic performance, linearity, gain flatness and mismatch tolerance performance. Developed around a unique upgradeable topology, it allows upgrades in both power and frequency.
All MILMEGA microwave amplifiers are backed with the industry's first fully expensed 5-year warranty. Together with demonstrable reliability, MILMEGA continues to be the proven choice for RF and Microwave Power Amplifiers.

Stand 21
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Contact: Matthew Farmer

MIRA employs 50 dedicated EMC engineers and technicians who draw on their experience in the automotive, off-highway, agricultural, industrial, military (Def Stan 59-41), emergency services and commercial electronics markets to offer test, design and problem resolution. MIRA is also actively involved in ISO, CISPR and SMMT EMC working groups.
MIRA's extensive suite of ISO 17025 accredited EMC laboratories are fully equipped for both vehicle and component testing and operate 24 hours a day to guarantee a flexible and cost effective service.
MIRA participates in the Automotive EMC Laboratory Recognition Program (AEMCLRP) and is recognised by Ford Motor Company and General Motors.

Stand 26
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rhobbs@panashield.co.uk
www.panashield.co.uk
Contact: Roger Hobbs

Panashield will be exhibiting products and information relating to their range of shielded rooms, anechoic chambers and ferrite and hybrid absorbers.
Panabolt modular RF shielded rooms can be easily disassembled, moved and re-erected or changed in size and configuration.
EMC Anechoic Chambers for testing to International Standards are designed and installed, starting with smaller compact chambers for pre-compliant engineering measurements through to larger full compliant, immunity and emission test chambers for measuring at 3m, 5m and 10m.
Our state of the art hybrid absorber, extending the chamber frequency range up to 40 GHz will be displayed. This hybrid absorber is **non-flammable** and does not emit toxic gases. It has a high broadband performance and is white, providing a bright working environment.
EMC Chambers are also provided for MIL STD testing and Free Space Chambers for RCS and Antenna measurements. A full range of resistive RF absorber is also available.

Stand 52
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jim.rowbotham@pexa.co.uk
www.pexa.co.uk
Contact: Jim Rowbotham

Pexa is the authorised distributor and service partner for Spraylat's range of highly conductive EM and RF shielding coatings. Spraylat's copper, silver and nickel based products offer excellent alternatives to plating processes such as electroless plating or vacuum metallisation. Spraylat's coatings are easily applied to complex geometries and can be retrofitted to most products.
With increasing legislation in Europe such as Reach and the Solvent Emissions Directive, Pexa and Spraylat are committed to leading the market in developing and offering sustainable technologies. Spraylat's electrically conductive coatings are available in both "Safe on Substrate" solvent based and water based formulations.
Pexa can provide technical support at all stages of the process, from technical specification right through to application processes and techniques.

Stand 27
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Fax: +44 (0)1793 784391
sales@ppm.co.uk
www.point2point.co.uk
www.ppm.co.uk
Contact: Phil Surman

Coming soon – EMC Shielded CANBus FOL
New – EV and Hybrid drive train test systems for battery simulation
PPM is the leading supplier of fibre optic link systems in the world. We pride ourselves on our customer support.
The point2point and Sentinel Fibre Optic Link ranges provide a means of conveying RF signals in the presence of intense electrical fields. ***point2point*** products offer bandwidths from high accuracy 14-bit DC to more than 3GHz.
The ***Sentinel II*** Intelligent Fibre Optic Link product range allows the user to remotely select inputs, link gain, pre-amplifier, calibrate signal etc. It offers additional shielding for higher field operation. Bandwidths of up to 1GHz are available.
PPM also supplies EMC test equipment including wideband current probes, current injection probes, electric and magnetic field probes, receivers, high voltage scope probes and high voltage attenuators. For more details please go to: **www.point2point.co.uk**

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www.q-par.com
Contact: Robert Lowther

Designs and manufactures antennas & components and complete systems across the radio frequency spectrum, for the EMC industry. High power, High field strength and focused antenna systems tailored to you needs are core to our business. Equipped to undertake all aspects RF & microwave design and consultancy to customer specification, including research and development through to manufacture, tests and field trials. Markets include surveillance, homeland security, military, commercial, EW and EMC testing. It specialises in microwave antennas, radar front ends and antenna positioners and control software. It has an extensive range of other microwave components – waveguide and co-axial, including a large range of horn and reflector antennas.

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www.rainfordemc.com
Contact: Tara Lei-Mitchell

Rainford EMC Systems is a market leader in anechoic chamber design and screen-roomed solutions.
We are a world-leading provider of EMC, antenna measurement facilities and specialist RF-protected environments such as EMPP and TEMPEST – ensuring compliance with the highest quality international requirements.
As a company our strength lies in our experience, expertise and flexible approach to our customers. We have well established designs for most applications such as:
- EMC
- Mobile communications
- Military
- Aircraft
- Automotive
- Electronics
- RF & Microwave
- Tempest
- MRI/ Medical

We are a UK based company operating on a global scale with representation in many countries throughout the world. We are also ISO9001 & ISO14001 certified for Design, manufacture, installation and testing of our product range.

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www.rohde-schwarz.co.uk
Contact: Andy Coombes

Meeting EMC standards is a basic requirement for every electrical and electronic device on the market. Legislation prescribes compliance with maximum values for electromagnetic interference (EMI) and minimum values for electromagnetic immunity or susceptibility (EMS).
Rohde & Schwarz is a pioneer in this area and has been a market leader in test equipment for EMC measurements for years:
Our EMC test products range from automatic test receivers for precompliance testing up to fully equipped turnkey EMC test centers. Moreover, we offer solutions for every budget.
Our customers include companies from all types of industry, regulatory authorities, independent test houses, as well as military and governmental organizations.

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www.syfer.com
Contact: Chris Noade

Syfer Technology is a UK manufacturer of EMI filters, planar capacitor arrays and surface mount filter components. Our expertise in ceramic capacitor manufacture enables us to provide filters with market-leading performance, coupled with the flexibility to offer custom solutions.
Our surface mount feedthrough EMI chips and X2Y Integrated Passive Components have seen recent range extensions, including 0603 versions, and they are also available qualified to AEC-Q200. In addition the X2Y chips now have 200V and 500V ratings.
Our panel mount feedthrough filter range has the highest capacitance values available. Breakthroughs in discoidal ceramic technology have enabled huge increases in maximum capacitance values, with working voltages up to 3kVdc. High current ratings are available up to 100A in the power filter range.
Our products are available through a network of UK and European Distributors, backed up by the highest standards of customer service and technical support.

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www.telonic.co.uk
Contact: Bob Lovell

We were established in the U.K. in 1966 as the sales and service operation of Telonic Industries Incorporated, a U.S. company specialising in R.F. products. In 1978 The Celesco Diesel Engine Smoke Meter manufactured by the newly name Telonic Berkeley U.S was added to our product range.
In 1982 following a management buy-out we became an independent company, but continued to sell Telonic Industries products.
We are the UK distributor for Kikusui Electronics Corporation of Japan (since 1976), EPS GmbH (Takasago) (2000), Digimess (2001) and Magna-Power in 2005.
We achieved approval to IS09001:2000 with NQA (National Quality Assurance)in 2005 and launched our new instrument hire website www.hireoption.co.uk.

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uksales@teseq.com
www.teseq.com
Contact: Cheryl Mathews

Teseq Proudly Presents - Decades of Leadership in EMC Testing.
Three decades of ESD Simulators, designed from inception to comply with tomorrow's standards. Forty years of advanced test solutions for EMC, applying the latest technology to set the standard for excellence in our field. We are proud to celebrate our history and are dedicated to continuing the challenge of industry leadership. With advanced technology, user friendly software, a worldwide network of certified experts and our local services around the globe.

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Contact: Angela Bond

Tioga Limited, founded in 1996, has developed into one of the UK's leading privately owned Contract Electronic Manufacturer (CEM), offering a broad spectrum of electronic assembly, complete product manufacturer and full 'turn-key' solutions, providing wide-ranging expertise and exceptional service to our customers.
We have an extensive facility at our Derby headquarters, with comprehensive capability for manufacturing complex and technically advanced products which can be tested and where required configured into systems ready for shipping to meet our customer's requirements.
Our production site has superb facilities for all aspects of surface mount assembly (6 fully automated, in-line SMD production lines) including micro BGA, BGA, fine pitch and high speed chip shooting as well as full capability for through hole assembly, systems build, test and configuration.
Highly experienced management, combined with well-trained staff, ensure that we achieve, internationally respected high quality standards, ISO 9001:2008 and comply with the manufacturing standard IPC-A-610 Class 3 Rev D.

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Since launching our range of compact, lightweight broadband TWT amplifiers in the early 1990s, TMD has been very successful in supplying products for EMC applications worldwide. These products have evolved and benefited from our expertise in high power military radar amplifiers.
TMD's standard amplifier range covers 1 – 40 GHz at up to 500 W CW and 40 kW pulsed and has gained a worldwide reputation for design innovation, including many unusual, high performance products.
The changing EMC testing standards continue to offer new technical challenges; in particular increasingly higher powers over a wide frequency range. TMD is ideally placed to meet this challenge, having successfully designed and manufactured a number of very high power TWTAs, and we continue to introduce new models on a regular basis. We also have an excellent track record of high product reliability and user support and satisfaction.
We continue to work closely with our partners; antenna experts Q-par Angus Ltd, BONN Elektronik GmbH (solid state RF & microwave amplifiers) and Frequensys Ltd (test equipment, consultancy & support); together providing optimum EMC test solutions for customers worldwide.

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TRaC delivers unrivalled excellence in testing, validation and certification for global approvals. Our comprehensive EMC services include pre- compliance & design assessments, market research, component validation, standards lobbying, approval strategies and consultancy to meet an exceptionally wide range of national and international EMC standards.
TRaC have the expertise in the fields of CE marking, defence and aerospace approvals, we are able to advise on how the requirements interface with one another, and we provide EMC testing to DEF STAN 59-411 & MIL STD 461, lightning and tempest testing.
TRaC can also provide combined services covering all aspects of **EMC, ATEX, machinery, radio, telecoms, environmental, FEA and safety testing.**
TRaC provides:

- Technical expertise - we understand your global qualification and approvals needs, and assist with the selection and application of the latest and most relevant standards and regulations
- A comprehensive range of test facilities, state-of-the-art test equipment and automated test processes - we provide you with high levels of test efficiency and scheduling flexibility
- Pre-qualification support - we assist you through critical design analysis and computer simulation
- Accreditation to ISO/IEC17025 by the United Kingdom Accreditation Service (UKAS) and we are approved to BS EN ISO 9000:2008 and accredited to national, international and industry specific approvals - we deliver unparalleled quality and customer service

Our secure facilities are designed and approved to meet the highest levels of national and commercial security for testing in privacy.

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Trescal is a global leading independent calibration company, specialising in the provision of calibration and test equipment management services across a number of industries.
In the UK, Trescal has the most extensive UKAS accredited technical capability and employs over 360 people of which the majority, are qualified engineers and technicians across a wide range of instrumentation and measurement disciplines.
Our strategy is to offer a truly one-stop solution for our clients' calibration and equipment support requirements. This is achieved by delivering a consistently high quality service that covers a broad range of parameters for laboratory and on-site calibration, equipment repair, instrument sales, inventory management and consultancy.
In determining the best solution to your service requirements, we are also able to draw upon the technical know-how of engineers across the wider Trescal organisation, which includes access to over 1000 calibration professionals working in 55 laboratories in 13 countries and 65 embedded customer sites in more than 30 countries.

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www.tuvps.co.uk
Contact: Simon Middleton

We understand the challenges you face in ensuring that your product is compliant with all legal requirements, including those concerning electromagnetic compatibility (EMC) and EMC Testing.
You need to resolve as many EMC issues as possible early at the design stage, understand all the standards and laws applicable to your product and meet any specific requests from your customers.
At TÜV SÜD, we strive to provide you with sound, prompt advice and to guide you through your EMC testing programme so that you can meet your deadlines for getting your product to market on time. It all comes down to reliable competence, and service with a personal touch, adding value to you, for all your EMC testing and consultancy services. Our test facilities in the South and Midlands are UKAS accredited and are the most comprehensively equipped EMC facilities in Europe.
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Contact: Philip Gale

Ultra Electronics Test Solutions specialise in the design and supply of first line/operational ('O') level Ground Support Equipment for the Military and Civil Aerospace Markets. We offer our customers the expertise and support of a strong, multi skilled engineering design team with many years experience.
Alongside our core products, Test Solutions can also design and supply Special-to-Type test equipment to meet individual customer requirements. We have a strong presence within the military domain with our equipment serving on a large portion of International Defence platforms, as well as supporting civil test applications within the production and maintenance environments.
Our business works closely with Original Equipment Manufacturers (OEMs) and end-users to develop equipment that meets stringent technical, quality and safety specifications. We also provide full training and product support services.

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Uvox will be concentrating their expertise in two main area for this year's EMCUK exhibition:

- Uvox EMC Shielding Gaskets
- Uvox Conductive Coating Service

With in-house **EMC Gasket Cutting and Manufacturing**, Uvox apply both accuracy and speed to your gasket designs. In a choice of materials, from conductive elastomers to wires-in-silicone to Form-In-Place gaskets!
The **Uvox Conductive Coating Service** continues to grow. This assists your plastic products in meeting EMC requirements. Uvox can offer advice on materials and masking methods to suit the project.
As well as showing examples of the above processes, Uvox will also exhibit its many EMC shielding products including: Wire Mesh gaskets; EMC Combination gaskets; Fabric-Over-Foam gaskets; Copper Conductive Tapes, Wires-in-Silicone gaskets; Electrically-Conductive Elastomers and pressed metal products for Board-Level shielding.

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The Wurth Group consist of 410 companies within 84 countries with 65,000 employees and sales of 7.5 billion € ($10.6 billion).
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Wurth Electronics UK Ltd. with offices in Manchester, England invites you to visit us at our stand at EMC UK 2011.
Bigger, better, faster and more than you expect: The new web catalogue is online. The catalogue includes a parameter search for products - an easy way to find your suitable component with just a few clicks.
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emcia

Electromagnetic Compatibility Industry Association

If you are serious about selling EMC products or services to Industry... then you should be a member. Come and see us at EMCUK.

The EMCIA was formed on 20th March 2002 for the benefit of companies involved in Supplying, Designing, Testing and Manufacturing EMC products. Networking lunches are held 3 times a year. The current President is Paul Duxbury.

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