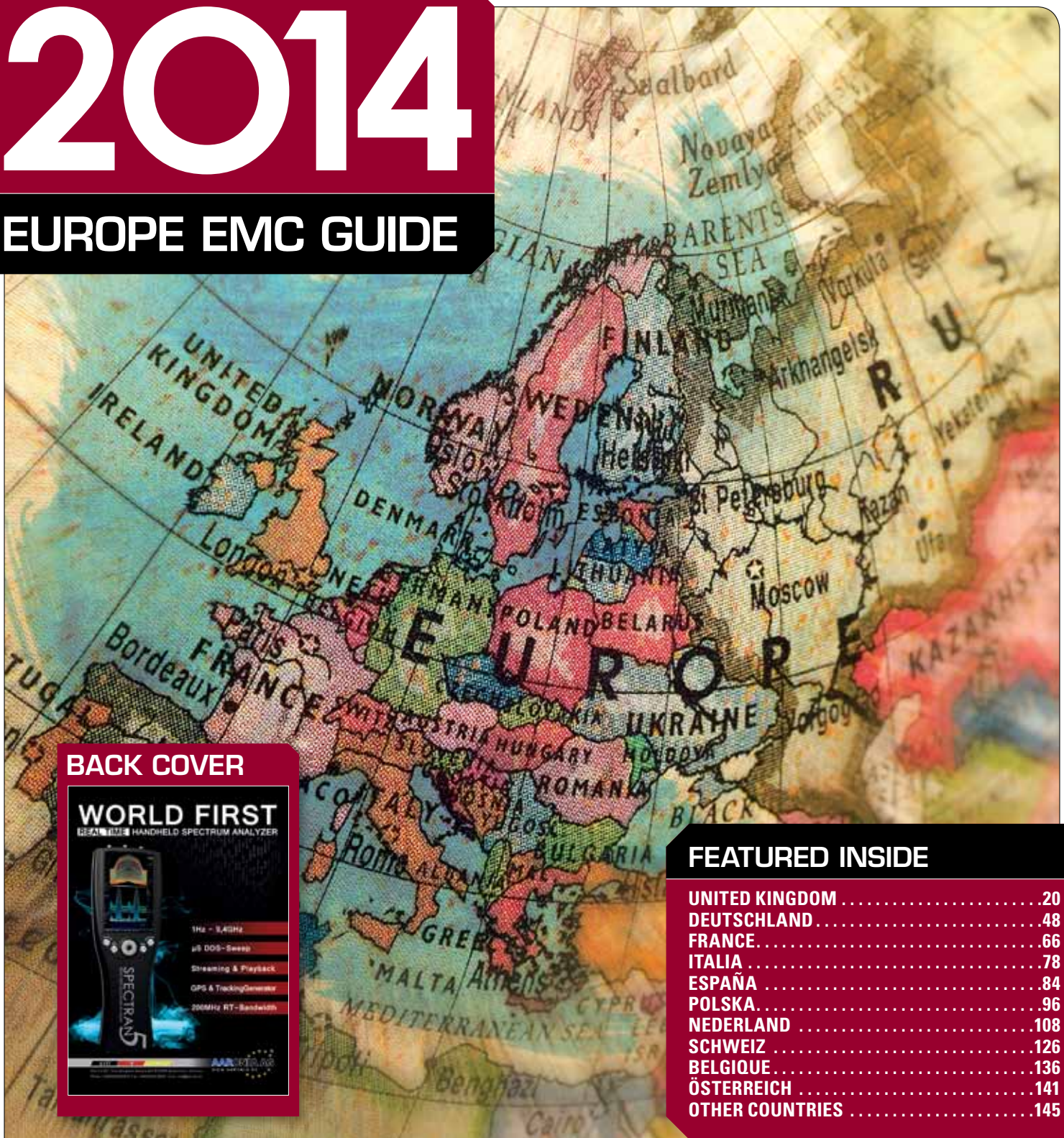
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THE INTERNATIONAL JOURNAL OF ELECTROMAGNETIC COMPATIBILITY

2014 EUROPE EMC GUIDE



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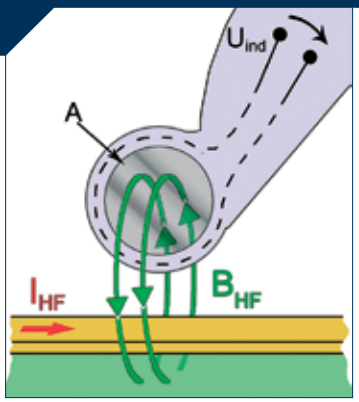
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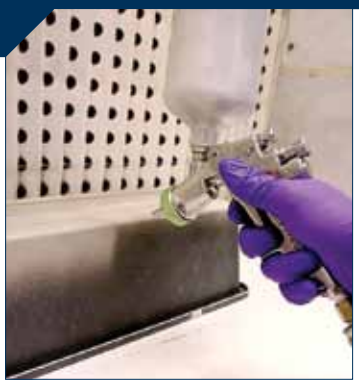
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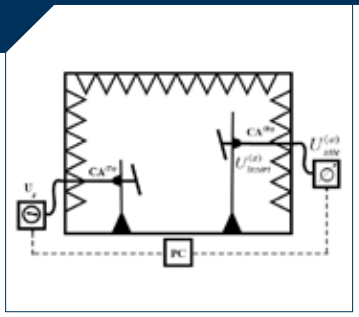
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MARCEL VAN DOORN, Technology & Strategy Manager, Philips Innovation Services
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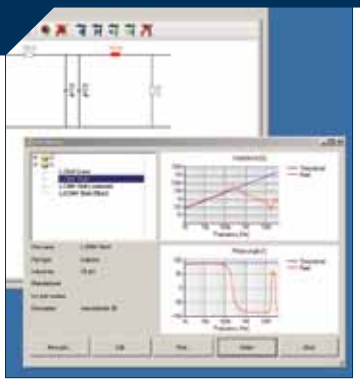
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A New Niche in EMC

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THE INTERNATIONAL JOURNAL OF ELECTROMAGNETIC COMPATIBILITY



DEAR READERS,

AS MANY OF OUR *Interference Technology* readers are located in Europe, we continue to provide the most current EMC information in our fourth annual Europe Guide, dedicated specifically to you.

We kick off this year's Europe Guide with a short article by one of our editorial board members, Keith Armstrong: "The First Practical Approach to EMC for Functional Safety (EMC Risk Management)."

Keith delves into EMC for Functional Safety — a niche interest currently but one he believes will soon be of greater interest in Europe, and elsewhere, as it develops into quite a large industry, essentially one about peoples' safety. He discusses how complying with emissions and immunity EMC test standards is insufficient (but necessary) for Functional Safety, and — because no affordable amount of EMC testing can prove compliance with even the lowest level of functional safety compliance — what practical design measures can be used to ensure that EMI will not cause unacceptable functional safety risks at any level.

We also feature articles on practical EMC filter design and optimization; new techniques in shielding for EMI; analysis of shielding effectiveness of board level shielding; using the near field measurement to reduce investigation time and cost; and more. All of these articles are written in each country's specific language. If you would like to read these articles in English, please visit our website at www.interferencetechnology.com and click on 'Articles.'

In this issue, we also provide you with details about important new European standards, a directory of products and services in each country, and a list of events that take place in Europe throughout the year.

There are many important shows that are important to the EMC community — all taking place in Europe. The International Exhibition with Conference on Electromagnetic Compatibility takes place 11-13 March 2014 in Düsseldorf, Germany. The event is Europe's leading conference on electromagnetic compatibility along with the EMV exhibition, offering a wide range of EMC-specific topics.

The EMC Europe 2014 show, another leading EMC symposium, will be held at The Swedish Exhibition & Congress Centre in Gothenburg, Sweden, 1-4 September, 2014. This show takes place every year, providing a place for EMC engineers across the continent to gather and exchange information.

Also on the calendar is European Microwave Week, which takes place 5-10 October, 2014 in Nurenberg, Germany. This European Microwave Week is a 6-day event that provides seminars, workshops and discussion groups where attendees can discuss relevant microwave, RF, wireless, defense/security and radar issues with leading manufacturers, institutes and industry bodies. We have a list of other important events and conferences in this issue.

Interference Technology is committed to providing the most accurate, up-to-date articles and information in the industry. If you have any questions, suggestions or ideas please email me at bstas@interferencetechnology.com. Thanks for reading!

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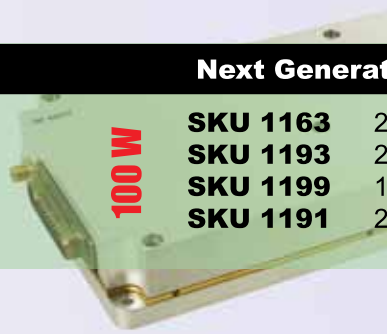
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STANDARDS EUROPE

Compliance with standards can make or break any new product. This section recaps some of the major new and revised EMC standards in the last year from the European standards organizations: the European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC) and the European Telecommunications Standards Institute (ETSI). Standards are sorted by reference number. Standards information and updates are featured in our weekly Interference Technology eNews; and we also have a vast list of standards at InterferenceTechnology.com - click on the Standards section.

European Committee for Electrotechnical Standardization (CENELEC)

EN 50413:2008/A1:2013

COMMITTEE: N/A

STATUS: Published

DATE OF PUBLICATION: 2014-09-02

TITLE: Basic Standard on Measurement and Calculation Procedures for Human Exposure to Electric, Magnetic and Electromagnetic Fields (0 Hz – 300 GHz)

SCOPE: This European Standard gives elements to establish methods for measurement and calculation of quantities associated with the assessment of human exposure to electric, magnetic and electromagnetic fields (EMF) in the frequency range from 0 Hz to 300 GHz. The major intention of this Basic Standard is to give the common background and information to relevant EMF standards. This Basic Standard cannot go into details extensively due to the broad frequency range and the huge amount of possible applications. Therefore, it is not possible to specify detailed calculation or measurement procedures in this Basic Standard. This standard provides general procedures only for those product and workplace categories for which there do not exist any relevant assessment procedures in any existing European EMF basic standard. If there exists an applicable European EMF standard focused on specific product or workplace categories, then the assessment shall follow that standard. If an applicable European EMF standard does not exist, but an applicable assessment procedure in another European EMF standard does exist, then that assessment procedure shall be used. This standard deals with quantities that can be measured or calculated in free space, notably electric and magnetic field strength or power density, and includes the measurement and calculation of quantities inside the body that forms the basis for protection guidelines. In particular the standard provides information on: definitions and terminology, characteristics of electric, magnetic and electromagnetic fields, measurement of exposure quantities, instrumentation requirements, methods of calibration, measurement techniques and procedures for evaluating exposure, and calculation methods for exposure assessment.

EN 50566:2013

COMMITTEE: GEL/106

STATUS: Published

DATE OF PUBLICATION: 2013-03-31

TITLE: Product Standard to Demonstrate Compliance of Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices Used by the General Public (30 MHz – 6 GHz)

SCOPE: Product standard to demonstrate compliance of radio frequency fields from handheld and body-mounted wireless communication devices (30 MHz - 6 GHz).

EN 55013:2013

COMMITTEE: IEC/SC CISPR/I

STATUS: Published

DATE OF PUBLICATION: 2014-04-22

TITLE: Sound and Television Broadcast Receivers and Associated Equipment – Radio Disturbance Characteristics – Limits and Methods of Measurement

SCOPE: CISPR 13:2009 applies to the generation of electromagnetic energy from sound and television receivers for the reception of broadcast and similar transmissions and from associated equipment. CISPR 13:2009 describes the methods of measurement applicable to sound and television receivers or associated equipment and specifies limits for the control of disturbance from such equipment. The frequency range covered extends from 9 kHz to 400 GHz. This fifth edition of CISPR 13 cancels and replaces the fourth edition published in 2001, its Amendment 1 (2003) and Amendment 2 (2006). This edition constitutes the introduction of the RMS-average detector as an alternative to quasi-peak and average detector for conducted and radiated emission measurements.

EN 60115-8:2012

COMMITTEE: IEC/TC 40

STATUS: Published

DATE OF PUBLICATION: 2013-08-13

TITLE: Fixed Resistors for Use in Electronic Equipment – Part 8: Sectional Specification – Fixed Surface Mount Resistors

SCOPE: IEC 60115-8:2009(E) is applicable to fixed surface mount resistors for use in electronic equipment. These resistors are typically described according to types (different geometric shapes) and styles (different dimensions). They have metalized terminations and are primarily intended to be mounted directly on to a circuit board. This second edition constitutes a technical revision and includes test conditions and requirements for lead-free soldering and assessment procedures meeting the requirements of a "zero defect" approach. The major technical changes with regard to the first edition include: introduction of a product classification based on application requirements, extension of the list of styles and dimensions, use of an extended scope of stability class definitions, extension of the lists of preferred values of ratings, inclusion of test conditions and requirements for lead-free soldering, for periodic overload and for resistance to electrostatic discharge (ESD); inclusion of a new set of severities for a shear test, inclusion of definitions for a test board, replacement of assessment level E and possible others by the sole assessment level EZ, meeting the requirements of a "zero defect" approach, inclusion of an extended endurance test, a flammability test, a temperature rise test, vibration tests, an extended rapid change of temperature test and a single pulse high-voltage overload test; and inclusion of requirements applicable to 0 resistors (jumpers).

EN 60255-26:2013

COMMITTEE: TC/SC 95

STATUS: Published

DATE OF PUBLICATION: 2014-03-28

TITLE: Measuring Relays and Protection Equipment – Part 26: Electromagnetic Compatibility Requirements

SCOPE: IEC 60255-26:2013 is applicable to measuring relays and protection equipment, taking into account combinations of devices to form schemes for power system protection including the control, monitoring, communication and process interface equipment used with those systems. . This standard specifies the requirements for electromagnetic compatibility for measuring relays and protection equipment. The requirements specified in this standard are applicable to measuring relays and protection equipment in a new condition and all tests specified are type tests only. This new edition includes the following technical changes with respect to the previous edition: definition of test specifications, test procedures and acceptance criteria per phenomena and port under test in one document; extension of radiated emission measurement for frequencies above 1 GHz; limitation of radiated emission measurement at 3 m distance for small equipment only; addition of zone A and zone B test level on surge test; extension of tests on the auxiliary power supply port by a.c. and d.c. voltage dips, a.c. component in d.c. (ripple) and gradual shut-down/start-up; and harmonization of acceptance criteria for immunity tests.

EN 60384-14:2013

COMMITTEE: TC/SC 40

STATUS: Published

DATE OF PUBLICATION: 2014-04-10

Title: Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification – Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains

Scope: IEC 60384-14:2013 applies to capacitors and resistor-capacitor combinations that will be connected to an a.c. mains or other supply with nominal voltage not exceeding 1, 000 V a.c. (r.m.s.) or 1,000 V d.c. and with a nominal frequency not exceeding 100 Hz. This fourth edition cancels and replaces the third edition published in 2005 and constitutes a technical revision.

EN 60512-28-100:2013

COMMITTEE: TC/SC 48B

STATUS: Published

DATE OF PUBLICATION: 2013-12-13

TITLE: Connectors for Electronic Equipment – Tests and Measurements – Part 28-100: Signal integrity Tests Up to 1,000 MHz on IEC 60603-7 and IEC 61076-3 Series Connectors – Tests 28a to 28g

Scope: IEC 60512-28-100:2013 specifies the test methods for transmission performance for IEC 60603-7 and IEC 61076-3 series connectors up to 1,000 MHz. It is also suitable for testing lower frequency connectors; however, the test methodology specified in the detailed specification for any given connector remains the reference

STANDARDS ORGANIZATIONS

- **CEN**
  the European Committee for Standardization

  CEN-CENELEC Management Centre
  Avenue Marnix 17
  B-1000 Brussels, Belgium
  + 32 2 550 08 11; Fax: + 32 2 550 08 19
  www.cen.eu/cenorm/homepage.htm

- **CENELEC**
  European Committee for Electrotechnical Standardization

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  +32 2 519 68 71; Fax: +32 2 519 69 19
  www.cenelec.org

- **ETSI**
  European Telecommunications Standards Institute

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- **IEC**
  International Electrotechnical Commission

  IEC Central Office
  3, rue de Varembé, P.O. Box 131
  CH - 1211 Geneva 20, Switzerland
  +41 22 919 02 11, Fax: +41 22 919 03 00
  info@iec.ch, www.iec.ch;
  IEC's EMC Zone: www.iec.ch/zone/emc/emc_entry.htm

- **CISPR**
  International Special Committee on Radio Interference

  IEC Central Office, 3
  rue de Varembé, P.O. Box 131, CH - 1211
  Geneva 20, Switzerland
  +41 22 919 02 11, Fax: +41 22 919 03 00
  info@iec.ch, www.iec.ch
  IEC's EMC Zone: ; www.iec.ch/zone/emc/emc_cis.htm

- **International Organization for Standardization**

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  ch. de la Voie-Creuse, Case postale 56
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  +41 22 749 01 11; Fax +41 22 733 34 30;
  www.iso.org

GOVERNMENT SITES

- **CEOC International**

  Secretariat, Rue du Commerce 20-22,
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conformance test for that connector. The test methods provided here are: insertion loss, return loss, near-end crosstalk (NEXT), far-end crosstalk (FEXT), transverse conversion loss (TCL) and transverse conversion transfer loss (TCTL). For the transfer impedance (ZT) test, see IEC 60512-26-100. For the coupling attenuation, see IEC 62153-4-12.

EN 61326-2:2013

COMMITTEE: IEC/SC 65A

STATUS: Published

DATE OF PUBLICATION: 2013-11-04

TITLE: Electrical Equipment for Measurement, Control and Laboratory Use – EMC Requirements – Part 2-6: Particular Requirements – In Vitro Diagnostic (IVD) Medical Equipment

SCOPE: IEC 61326-2-6:2012 specifies minimum requirements for immunity and emissions regarding electromagnetic compatibility for in vitro diagnostic medical equipment, taking into account the particularities and specific aspects of this electrical equipment and their electromagnetic environment. This second edition cancels and replaces the first edition published in 2005 and constitutes a technical revision. It includes an update of the document with respect to IEC 61326-1:2012.

EN 61587-3:2013

COMMITTEE: TC/SC 48D

STATUS: Published

DATE OF PUBLICATION: 2013-12-13

TITLE: Mechanical Structures for Electronic Equipment – Tests for IEC 60917 and IEC 60297 – Part 3: Electromagnetic Shielding Performance Tests for Cabinets and Subracks

SCOPE: IEC 61587-3:2013 specifies the tests in the frequency range of 30 MHz to 3 000 MHz for empty cabinets and subracks concerning electromagnetic shielding performance. Stipulated attenuation values are chosen for the definition of the shielding performance level of cabinets and subracks for the IEC 60297 and IEC 60917 series. The shielding performance levels are chosen with respect to the requirements of the typical fields of industrial application. They will support the measures to achieve electromagnetic compatibility but cannot replace the final testing of compliance of the equipped enclosure. This second edition cancels and replaces the first edition issued in 2006 and constitutes a technical revision.

EN 61788-16:2013

COMMITTEE: TC/SC 90

STATUS: Published

DATE OF PUBLICATION: 2013-11-20

TITLE: Superconductivity – Part 16: Electronic Characteristic Measurements – Power-Dependent Surface Resistance of Suoperconductors at Microwave Frequencies

SCOPE: IEC 61788-16:2013 involves describing the standard measurement method of power-dependent surface resistance of superconductors at microwave frequencies by the sapphire resonator method. The measuring item is the power dependence of Rs at the resonant frequency. This method is the applicable for a frequency in the range of 10 GHz and for an input microwave power lower than 37 dBm (5 W). The aim is to report the surface resistance data at the measured frequency and that scaled to 10 GHz.

EN 62037-5:2013

COMMITTEE: IEC/TC 46

STATUS: Published

DATE OF PUBLICATION: 2013-11-20

TITLE: Passive RF and Microwave Devices, Intermodulation Level Measurement – Part 5: Measurement of Passive Intermodulation in Filters

SCOPE: IEC 62037-5:2013(E) defines test fixtures and procedures recommended for measuring levels of passive intermodulation generated by filters typically used in wireless communication systems. The purpose is to define qualification and acceptance test methods for filters for use in low intermodulation (low IM) applications.

EN 62037-6:2013

COMMITTEE: IEC/TC 46

STATUS: Published

DATE OF PUBLICATION: 2013-11-20

TITLE: Passive RF and Microwave Devices, Intermodulation Level Measurement – Part 6: Measurement of Passive Intermodulation in Antennas

SCOPE: IEC 62037-6:2013(E) defines test fixtures and procedures recommended for measuring levels of passive intermodulation generated by antennas typically used in wireless communication systems. The purpose is to define qualification and acceptance test methods for antennas for use in low intermodulation (low IM) applications.

EN 62215-3:2013

COMMITTEE: IEC/SC 47A

STATUS: Published

DATE OF PUBLICATION: 2014-05-21

TITLE: Integrated Circuits – Measurement of Impulse Immunity – Part 3: Non-Synchronous Transient Injection Method

SCOPE: IEC 62215-3:2013 specifies a method for measuring the immunity of an integrated circuit (IC) to standardized conducted electrical transient disturbances. The disturbances, not necessarily synchronized to the operation of the device under test (DUT), are applied to the IC pins via coupling networks. This method enables understanding and classification of interaction between conducted transient disturbances and performance degradation induced in ICs regardless of transients within or beyond the specified operating voltage range.

European Committee for Standardization (CEN)

EN 50117-1:2002/A2:2013

COMMITTEE: CLC/SC 46XA

STATUS: Published

DATE OF PUBLICATION: 2014-06-17

TITLE: Coaxial Cables – Part 1: Generic Specification

Scope: Covers coaxial cables for use in analogue and digital systems. This standard should be used in conjunction with EN 50290-1-1. Coaxial cables covered by this standard operate in transverse electromagnetic mode (TEM) and are suitable for use in a wide range of digital and

analogue applications, including CATV, RF systems, instrumentation, broadcasting, telecommunications and data network systems. Various constructions and materials provide for indoor and outdoor applications, including underground and overhead installations, as well as other environmental protection characteristics. Generally, cables are designed for use in 50 Ohm and 75 Ohm characteristic impedance systems, although other types (e.g. 93/95 Ohm) are also covered. Coaxial cables defined by this standard may be incorporated into hybrid cable constructions with optical fiber or multi-element cable components. All cables covered by this standard may be subjected to voltages greater than 50 V a.c. or 75 V d.c. However, these cables are not intended for direct connection to the mains electricity supply or other low impedance sources.

EN 12016:2013

COMMITTEE: CEN/TC 10

STATUS: Published

DATE OF PUBLICATION: 2014-02-28

TITLE: Electromagnetic Compatibility – Product Family Standard for Lifts, Escalators and Moving Walks – Immunity

SCOPE: This standard specifies the immunity performance criteria and test levels for apparatuses used in lifts, escalators and moving walks that are intended to be permanently installed in buildings, including the basic safety requirements in regard to their electromagnetic environment. These levels represent essential EMC requirements. The standard refers to EM conditions as existing in residential, office and industrial buildings. This standard addresses commonly-known EMC related hazards and hazardous situations relevant to lifts, escalators and moving walks when they are used as intended and under the conditions foreseen by the lift installer or escalator and/or moving walk manufacturer. However, the performance criteria and test levels for apparatuses/assembly of apparatuses used in general function circuits does not cover situations with an extremely low probability of occurrence. This standard does not apply to other apparatus already proven to be in conformity to the EMC Directive and not related to the safety of the lift, escalator or moving walk, such as lighting apparatus, communication apparatus, etc. This standard does not apply to electromagnetic environments such as radio-transmitter stations, railways and metros, heavy industrial plants, or electricity power stations, which require additional investigations. This standard is not applicable to apparatuses that were manufactured before the date of its publication as EN 12016.

European Telecommunications Standards Institute (ETSI)

EN 301 489-34

COMMITTEE: ERM EMC

STATUS: Published

DATE OF PUBLICATION: 2013-05-24

TITLE: EMC and Radio Spectrum Matters (ERM); EMC Standard for Radio Equipment and Services; Part 34: Specific Conditions for External Power Supply (EPS) for Mobile Phones

SCOPE: To reduce the RF field immunity and RF conducted immunity levels from 10 V/m and 10 Vrms to 3V/m and 3Vrms respectively with the exception of the relevant uplink frequencies.

EN 301 489-50

COMMITTEE: ERM EMC

STATUS: Published

DATE OF PUBLICATION: 2013-03-12

TITLE: EMC and Radio Spectrum Matters (ERM); EMC Standard for Radio Equipment and Services; Part 50: Specific Conditions for Cellular Communication Base Station (BS), Repeater and Ancillary Equipment

Scope: Covers digital cellular base station equipment, repeaters and associated ancillary equipment with respect to electromagnetic compatibility. Includes CDMA Direct Spread (UTRA and E-UTRA); CDMA Multi-carrier; GSM BS equipment meeting Phase 2, and Phase 2+ requirements; Multi-Standard Radio (MSR); and OFDMA TDD WMAN (Mobile WiMAX) (WMAN).

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  mail.gva@efta.int; www.efta.int

- **European Commission**
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  http://ec.europa.eu

- **European New Legislative Framework for marketing of products**
  http://ec.europa.eu/enterprise/policies/single-market-goods/regulatory-policies-common-rules-for-products/new-legislative-framework

- **European Environment Agency**
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  http://www.efta.int

- **Rapex - Rapid Alert System for non-food dangerous products**
  EU consumer alerts about unsafe products
  European Commission, Health & Consumers Directorate-General, B – 1049 Brussels, Belgium; http://ec.europa.eu/consumers/dyna/rapex/rapex_archives_en.cfm

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  www.efndt.org

EN 302 065-1

COMMITTEE: ERM TGUWB

STATUS: Being Reviewed

DATE OF PUBLICATION: 2013-12-31

TITLE: EMC and Radio Spectrum Matters (ERM); Short Range Devices (SRD) using Ultra-Wideband Technology (UWB) for Communication Purposes; Harmonized EN Covering the Essential Requirements of Article 3.2 of the R&TTE Directive; Part 1: Common Technical Requirements

SCOPE: Revision of EN for review and maintenance to include new simplified approach for standardization framework for UWB in ETSI. The revised EN will also introduce a multipart structure and reflect the changes in the current regulation.

International Electrotechnical Commission (IEC)

CISPR 15:2013

COMMITTEE: TC/SC CIS/F

STATUS: Published

DATE OF PUBLICATION: 2013-05-08

T**ITLE:** Limits and Methods of Measurement of Radio Disturbance Characteristics of Electrical Lighting and Similar Equipment

SCOPE: CISPR 15:2013 applies to the emission (radiated and conducted) of radio frequency disturbances from the following: all lighting equipment with a primary function of generating and/or distributing light for illumination purposes and intended either for connection to the low voltage electricity supply or for battery operation; the lighting part of multi-function equipment where one of the primary functions of this is illumination; independent auxiliaries exclusively for use with lighting equipment; UV and IR radiation equipment; neon advertising signs; street/flood lighting intended for outdoor use; and transport lighting (installed in buses and trains). Lighting equipment for aircraft and airports and apparatuses for which the electromagnetic compatibility requirements in the radio-frequency range are explicitly formulated in other CISPR standards are excluded from the scope of this standard. The frequency range covered is 9 kHz to 400 GHz. This eighth edition cancels and replaces the seventh edition published in 2005, its Amendment 1 (2006) and Amendment 2 (2008).

IEC 60358-2:2013

COMMITTEE: 33

STATUS: Published

DATE OF PUBLICATION: 2013-08-12

TITLE: Coupling Capacitors and Capacitor Dividers – Part 2: AC or DC Single-Phase Coupling Capacitor Connected Between Line and Ground for Power Line Carrier-Frequency (PLC) Application

SCOPE: IEC 60358-2:2013 applies to AC or DC single-phase coupling capacitors with a rated voltage greater than 1,000 V that are connected between line and ground with a low voltage terminal either permanently earthed or connected to a device for power line carrier-frequency (PLC) applications at frequencies from 30 kHz to 500 kHz or similar applications (DC or AC) at power frequencies from 15 Hz to 60 Hz. The transmission requirements for coupling devices for power line carrier (PLC) systems are defined in IEC 60481.

IEC 60512-28-100:2013

COMMITTEE: 48B

STATUS: Published

DATE OF PUBLICATION: 2013-02-06

TITLE: Connectors for Electronic Equipment – Tests and Measurements – Part 28-100: Signal Integrity Tests Up to 1,000 MHz on IEC 60603-7 and IEC 61076-3 Series Connectors - Tests 28a to 28g

SCOPE: IEC 60512-28-100:2013 specifies the test methods for transmission performance for IEC 60603-7 and IEC 61076-3 series connectors up to 1,000 MHz. It is also suitable for testing lower frequency connectors, however the test methodology specified in the detailed specification for any given connector remains the reference conformance test for that connector. The test methods provided include insertion loss, return loss, near-end crosstalk (NEXT), far-end crosstalk (FEXT), transverse conversion loss (TCL) and transverse conversion transfer loss (TCTL). For the transfer impedance (ZT) test, see IEC 60512-26-100. For the coupling attenuation, see IEC 62153-4-12.

IEC 61000-3-3:2013

COMMITTEE: 77A

STATUS: Published

DATE OF PUBLICATION: 2013-05-14

TITLE: Electromagnetic Compatibility (EMC) – Part 3-3: Limits – Limitation of Voltage Changes, Voltage Fluctuations and Flicker in Public Low-Voltage Supply Systems for Equipment with Rated Current ≤16 A Per Phase and Not Subject to Conditional Connection

SCOPE: IEC 61000-3-3:2013 is concerned with the limitation of voltage fluctuations and flicker impressed on the public low-voltage system. It specifies limits of voltage changes which may be produced by equipment tested under specified conditions, and gives guidance on methods of assessment. It is applicable to electrical and electronic equipment with an input current equal to or less than 16 A per phase that is intended to be connected to public low-voltage distribution systems of between 220 V and 250 V line to neutral at 50 Hz and not is subject to conditional connection. IEC 61000-3-3 has the status of a product family standard within the IEC 61000 series. This third edition cancels and replaces the second edition published in 2008. This edition constitutes a technical revision which takes account of the changes made in IEC 61000-4-15:2010.

IEC 61169-1:2013

COMMITTEE: 46F

STATUS: Published

DATE OF PUBLICATION: 2013-07-10

TITLE: Radio Frequency Connectors – Part 1: Generic Specification – General Requirements and Measuring Methods

Scope: IEC 61169-1:2013(E), which is a generic specification, relates to radio frequency connectors for RF transmission lines used in telecommunications, electronics and similar equipment. It provides the basis for the sectional standards, which apply to individual connector types. It is intended to establish uniform concepts and procedures concerning terminology, standard ratings and characteristics, testing and measuring procedures concerning

electrical, mechanical and climatic properties; and classification of connectors with regard to climatic testing procedures involving temperature and humidity. The test methods and procedures of this standard are intended for acceptance and type approval testing. This second edition cancels and replaces the first edition, published in 1992, and its Amendments 1 (1996) and 2 (1997).

IEC/PAS 62825:2013

COMMITTEE: CIS/I

STATUS: Published

DATE OF PUBLICATION: 2013-01-10

TITLE: Methods of Measurement and Limits for Radiated Disturbances from Plasma Display Panel TVs in the Frequency Range 150 kHz to 30 MHz

SCOPE: IEC/PAS 62825:2013(E), which is a Publicly Available Specification (PAS), applies to plasma display panel TVs intended for use in residential or commercial environments that have a visible display area with a diagonal dimension of 1 m or greater and are within the scope of CISPR 13 or CISPR 32. This specification covers emission requirements related to radiated radio-frequency (RF) disturbances in the frequency range 150 kHz to 30 MHz. It specifies suitable limits and methods of measurement for the assessment of radiated RF disturbances. The requirements specified in this specification are essential EMC requirements that should be met in order to protect radio reception in the frequency range up to 30 MHz at locations where these display devices are operated in the field. While application of this specification is recommended, the comprehensive set of normative EMC emission requirements can also be found in CISPR 13 or CISPR 32. Use of this specification does not remove the obligation to apply any other CISPR publication. The objectives of this specification are to establish supplementary requirements that provide an adequate level of protection of the radio frequency spectrum, allowing radio reception as intended in the frequency range 150 kHz to 30 MHz, and to specify procedures to ensure the reproducibility of measurement and the repeatability of obtained results.

International Standards Organization (ISO)

ISO 11451-4:2013

COMMITTEE: ISO/TC 22/SC 3

STATUS: Published

DATE OF PUBLICATION: TBD

TITLE: Road Vehicles: Vehicle Test Methods for Electrical Disturbances from Narrowband Radiated Electromagnetic Energy – Part 4: Bulk Current Injection (BCI)

Scope: Specifies bulk current injection (BCI) test methods for testing the electromagnetic immunity of electronic components for passenger cars and commercial vehicles, regardless of the propulsion system (e.g. spark-ignition engine, diesel engine, electric motor). The electromagnetic disturbance considered in ISO 11451-4:2013 is limited to continuous narrowband electromagnetic fields.

ISO 13832:2013

COMMITTEE: ISO/TC 20/SC 1

STATUS: Published

DATE OF PUBLICATION: 2013-03-19

TITLE: Aerospace – Wire, Aluminum Alloy and Copper-Clad Aluminum Conductors – General Performance Requirements

SCOPE: ISO 13832:2013 specifies the dimensions, electrical characteristics and mechanical characteristics of aluminum-based and copper -clad aluminum (CCA) conductors for lightweight aircraft electrical cables and aerospace applications. It applies to stranded conductors over the nominal cross-sectional area range 0,22 mm2 to 107 mm2 inclusive but is not applicable to conductors for conventional copper-based cables, fire-resistant cables or for thermocouple extension cables. Conductors for copper-based cables are specified in ISO 2635, fire-resistant cables are specified in ISO 1967 and thermocouple extension cables are specified in ISO 8056 1.

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EMC EVENTS

Keep up on important events in the electromagnetic compatibility community in this section. Visit Interference Technology online at www.interferencetechnology.eu for even more listings. If you would like to add an event, e-mail details to editor Belinda Stasiukiewicz at bstas@interferencetechnology.com.

International Conference on Integrated Power Electronics (CIPS) 2014

WHEN: 25-27 February 2014

WHERE: Nuremberg, Germany

WHAT: The 8th International Conference on Integrated Power Electronics Systems focuses on three main aspects regarding integrated power electronics systems: mechatronic integration, hybrid systems and ultra-high-power density integration, and system and component reliability. Engineers from industry and academia are invited to discuss and share information on basic technologies for integrated power electronics systems, as well as new future applications.

INFORMATION: http://conference.vde.com/cips/2014/Pages/default.aspx

International Workshop on Antenna Technology

WHEN: 4-6 March 2014

WHERE: Sydney, Australia

WHAT: The International Workshop on Antenna Technology (iWAT) is an annual forum for the exchange of information on the research and development of innovative antenna technologies. Topics include small antennas, innovative structures and materials and applications.

INFORMATION: www.iwat2014.org

EMV 2014

WHEN: 11-13 March 2014

WHERE: Düsseldorf, Germany

WHAT: Europe's leading application-oriented conference on electromagnetic compatibility highlights the requirements of EMC and provides a comprehensive information program that includes reports on the newest products and developments. Specialists from all over the world are available for technical discussion.

INFORMATION: www.mesago.de/en/EMV/home.htm

Smart Systems Integration 2014

WHEN: 26-27 March 2014

WHERE: Vienna, Austria

WHAT: Smart Systems Integration is the international communication platform for research institutes and manufacturers to exchange information on smart systems integration and to create the basis for successful research cooperation with a focus on Europe.

INFORMATION: www.mesago.de/en/SSI/home.htm

Design, Automation & Test in Europe Conference (DATE) 2014

WHEN: 24-28 March 2014

WHERE: Dresden, Germany

WHAT: DATE is an international event and networking opportunity for the design and engineering of systems-on-chip, systems-on-board and embedded systems software. Suppliers of development tools and platforms for hardware and software development exhibit a range of information and products relating to front-end to back-end chip design, silicon test and manufacturing, system architecture and embedded software implementation.

INFORMATION: www.date-conference.com

European Conference on Antennas & Propagation (EuCAP) 2014

WHEN: 6-11 April 2014

WHERE: The Hague, The Netherlands

WHAT: The 8th annual European Conference on Antennas & Propagation provides a forum for the exchange of scientific and technical information on the latest results and developments in antenna theory and technology, electromagnetic wave propagation and antenna measurement techniques. Members of both Industry and academia are welcome to attend.

INFORMATION: www.eucap2014.org

ExpoElectronica 2014

WHEN: 15-17 April 2014

WHERE: Moscow, Russia

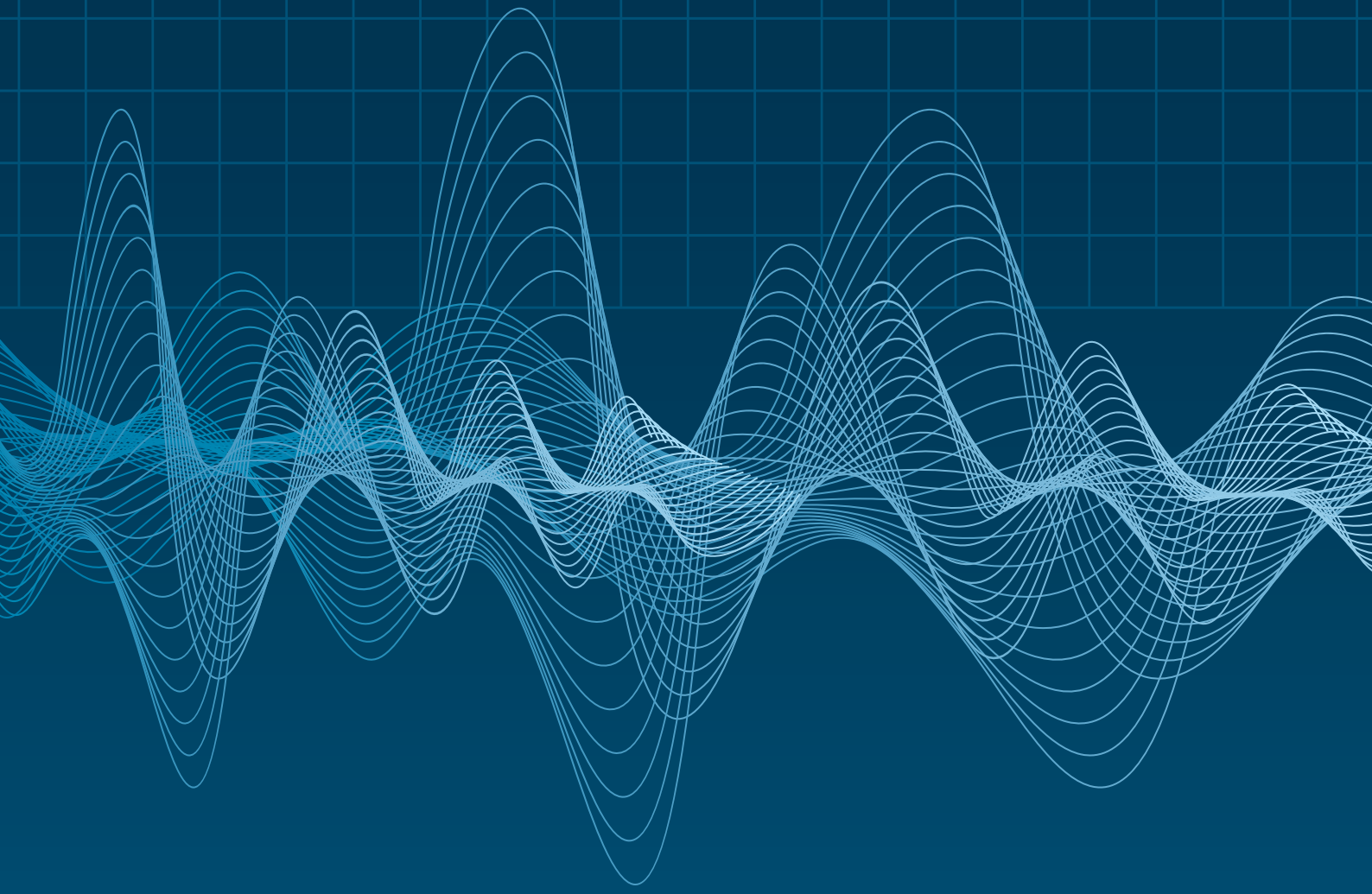
WHAT: ExpoElectronica is one of the largest exhibitions for electronic components and technologies in Russia and Eastern Europe, and consists of three smaller trade fairs. The largest, ExpoElectronica, is an international trade fair for components, PCBs and electronic production while ElectronTechExpo focuses on electronics manufacturing technology. The newest trade fair, LEDTechExpo, covers LED solutions, chips and production facilities.

INFORMATION: http://expoelectronica.primexpo.ru/en

emv

International Exhibition and Conference
on Electromagnetic Compatibility (EMC)
Duesseldorf, 11–13 March 2014

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International Conference on Electromagnetic Fields, Health and Environment (EHE) 2014

WHEN: 24-26 April 2014

WHERE: Porto, Portugal

WHAT: The 5th International Conference on Electromagnetic Fields, Health and Environment is a world forum for a multi-discipline audience with various backgrounds to present, review and discuss the new developments and trends on electromagnetic field analysis, simulation and application with significance to the human health.

INFORMATION: www.apdee.org/conferences/ehe2014/index.php

SVIAZ-EXPOCOMM 2014

When: 13-16 May 2014

Where: Moscow, Russia

What: The International Exhibition for Telecommunications, Control Systems, IT and Communication Services is an information technology and telecommunication event used by many overseas IT manufacturers to promote their products and develop their business in Russia. The conference showcases the latest innovative products, technologies and services, and serves as a place for industry professionals to network and exchange information.

INFORMATION: www.sviaz-expocomm.ru/en

European Wireless 2014

When: 14-16 May 2014

Where: Barcelona, Spain

What: The European Wireless Conference focuses on all aspects of telecommunications, including ongoing research, new products and technology. This year's conference will focus on "Energy- and Spectrally-Efficient Broadband Communication Systems."

INFORMATION: www.ew2014.org

International Conference on Numerical Electromagnetic Modeling and Optimization for RF, Microwave and Terahertz Applications (NEMO) 2014

WHEN: 14-16 May 2014

WHERE: Pavia, Italy

WHAT: NEMO2014 is a brand new international conference designed to bring together experts and practitioners of computational electromagnetics for RF, microwave and terahertz applications. This conference is the ideal venue to share new ideas on numerical techniques for electromagnetic modeling, propose efficient design algorithms and tools, and anticipate the modeling needs of future technologies and applications.

INFORMATION: http://nemo-ieee.org

eCarTech 2014

WHEN: 20-22 May 2014

WHERE: Paris, France

WHAT: eCarTec Paris and its sister trade fair, eCarTech Munich, are the leading events for electric mobility. Conference topics include electric vehicles, drive vehicles, drive and motor techniques, engineering and subcontracting, energy and infrastructure, maintenance and parts, energy storage technology and more.

INFORMATION: www.ecartec.de/en/ecartec-paris

Power Conversion Intelligent Motion (PCIM) 2014

WHEN: 20-22 May 2014

WHERE: Nuremberg, Germany

WHAT: PCIM offers numerous oral and poster sessions, seminars and tutorials that provide state-of-the-art application information on power electronics. Specialists from all over the world will report on their latest products and applications and will be available for technical discussions.

INFORMATION: www.mesago.de/en/PCIM

IEEE Conference on Electromagnetic Field Computation (CEFC) 2014

WHEN: 25-28 May 2014

WHERE: Annecy, France

WHAT: The 16th biennial IEEE Conference on Electromagnetic Field Computation offers scientists and engineers worldwide a forum in which to discuss the latest developments in modeling and simulation methodologies for the analysis of electromagnetic fields and wave interactions, with an application emphasis on the computer-aided design of low and high frequency devices, components and systems.

INFORMATION: http://cefc2014.org

International Symposium on Industrial Electronics (ISIE) 2014

WHEN: 1-4 June 2014

WHERE: Istanbul, Turkey

WHAT: The 23rd IEEE International Symposium on Industrial Electronics is an international conference for sharing breakthroughs in research, emerging technologies, and success stories in industrial electronics and its applications. Researchers and engineers from industry, research and academia are invited to participate in an array of presentations, tutorials, and social activities for the advancement of science, technology, engineering education and fellowship.

INFORMATION: www.isie.boun.edu.tr

International Conference on Microwaves, Radar and Wireless Communications (MIKON) 2014

WHEN: 16-18 June 2014

WHERE: Lviv, Ukraine

WHAT: The 20th International Conference on Microwaves, Radar and Wireless Communications offers a forum to discuss research, design and application of components and systems relating to all areas of the electromagnetic spectrum.

INFORMATION: www.mikon2014.lp.edu.ua

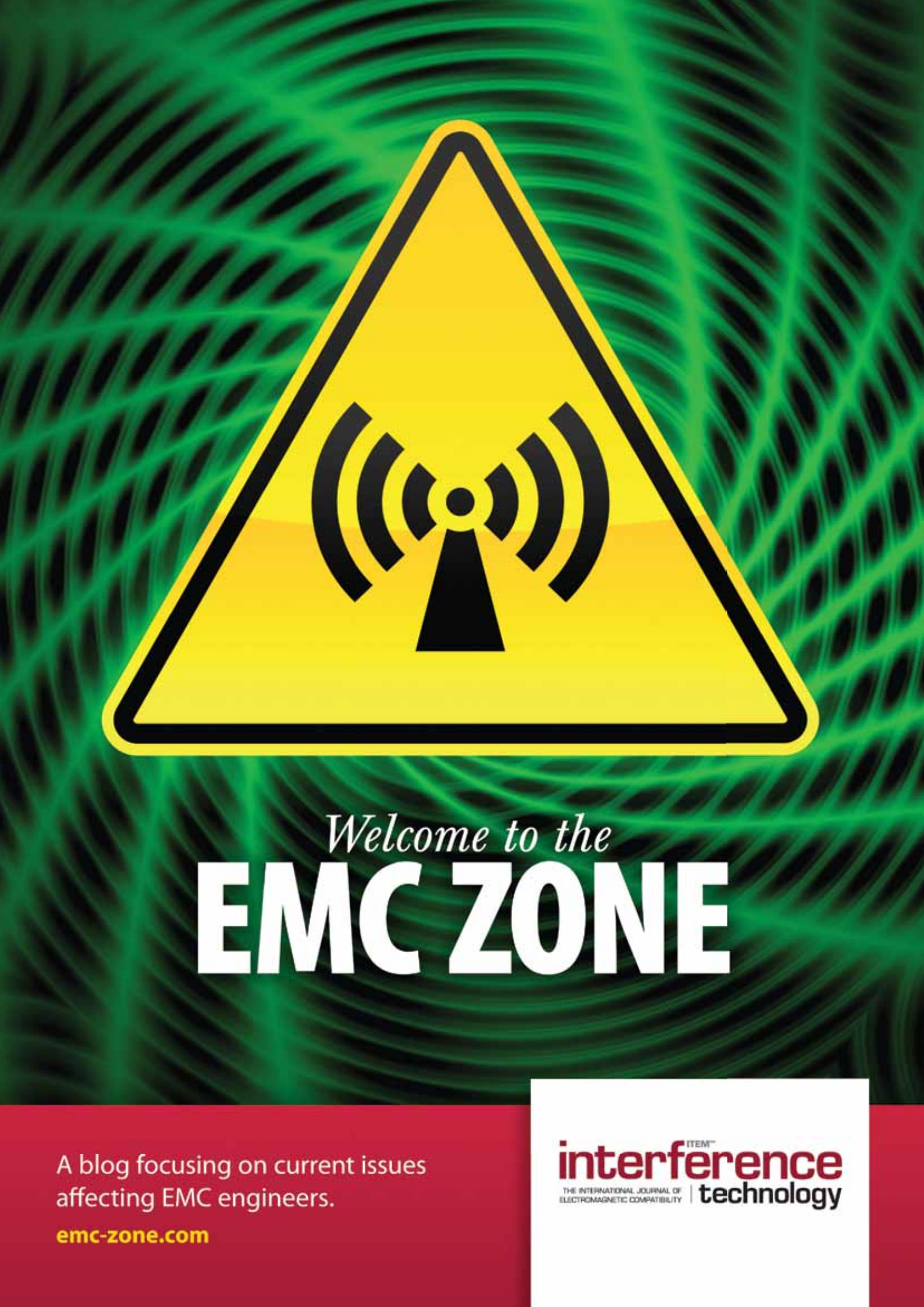
IEEE International Symposium on Electromagnetic Compatibility 2014

WHEN: 3-8 August 2014

WHERE: Raleigh, North Carolina, USA

WHAT: The 2014 IEEE International Symposium on Electromagnetic Compatibility is a comprehensive event featuring technical seminars and workshops, industry meetings, professional awards, social events, products and services demonstrations, and a companion program.

INFORMATION: www.emc2014.org



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IEEE International Conference on Ultra-Wideband (ICUWB) 2014

WHEN: 1-3 September 2014

WHERE: Paris, France

WHAT: The 2014 IEEE International Conference on Ultra-Wideband provides a forum for the latest UWB systems, technologies applications. ICUWB welcomes both original research and developments in all areas of UWB technology, as well as related applications including cognitive radio, sensor networks and the Internet of Things.

INFORMATION: www.icuwb2014.org

EMC Europe 2014

WHEN: 1-4 September 2014

WHERE: Gothenburg, Sweden

WHAT: EMC Europe is a leading EMC symposium in Europe created from a series of independent EMC conferences in Worclaw, Zurich and Rome that ran in alternating years. This year, EMC Europe extends an invitation to all those working in the field of electromagnetic compatibility to participate in an international forum for the exchange of technical information on EMC.

INFORMATION: www.emceurope2014.org

IRMMW-THz 2014

WHEN: 14-19 September 2014

WHERE: Tucson, Arizona, USA

WHAT: Established in 1974, the International Conference on Infrared, Millimeter, and Terahertz Waves is the oldest and largest continuous forum specifically devoted to the field of ultra-high-frequency electronics and applications. The conference welcomes the sharing of scientific and technical knowledge in the areas and disciplines involving infrared, millimeter and terahertz waves.

INFORMATION: www.irmmw-thz.orgindex.html

Metamaterials 2014

WHEN: 25-28 August 2014

WHERE: Copenhagen, Denmark

WHAT: The 8th International Congress on Advanced Electromagnetic Materials in Microwaves and Optics is dedicated to the research of artificial electromagnetic surfaces and materials and their applications from RF to optical.

INFORMATION: http://congress2014.metamorphose-vi.org

European Microwave Week 2014

WHEN: 5-10 October 2014

WHERE: Rome, Italy

WHAT: The European Microwave Week is a five-day event that provides seminars, workshops and discussion groups where attendees can discuss relevant microwave, RF, wireless, defense/security and radar issues with leading manufacturers, researchers and industry bodies. EMW consists of three conferences: The European Microwave Conference (EuMC), the European Microwave Integrated Circuits Conference (EuMIC) and the European Radar Conference (EuRAD).

INFORMATION: www.eumweek.com

EMC UK Exhibition and Conference 2014

WHEN: October 2014

WHERE: Newbury, UK

WHAT: The two-day EMC UK Exhibition and Conference focuses on all aspects of the EMC industry, including new directives, components, test techniques, test equipment and EMC modeling software. Industry members are welcome to attend a wide variety of technical forums, practical training sessions and networking events, as well as an EMC products and services exhibition.

INFORMATION: www.emcuk.co.uk

Radar 2014

WHEN: 13-17 October 2014

WHERE: Lille, France

WHAT: Radar 2014 covers all aspects of radar systems for civil, security and defense applications, including waveform design, beamforming, signal processing, emerging applications and technologies and radar environment.

INFORMATION: www.radar2014.org

Aerospace Testing Russia 2014

WHEN: 28-30 October 2014

WHERE: Moscow, Russia

WHAT: The International Exhibition of Testing Equipment, Systems and Technologies for the Aerospace Industry presents the latest developments and methods of aerospace component and subsystem testing to aerospace specialists from Russia and CIS countries.

INFORMATION: www.aerospace-expo.ru/en-GB

ID World International Congress 2014

WHEN: TBD

WHERE: TBD

WHAT: The ID World International Congress is the prime conference on the evolving world of biometrics, RFID, smart card technologies and data collection. It is the only international forum that looks at the advanced ID industry as a whole, rather than focusing on a specific technology or vertical sector. This conference is co-located with Euro ID, Germany's trade exhibition for users, manufacturers, distributors, suppliers and system integrators in the field of identification.

INFORMATION: www.mesago.de/en/IDW/The_conference/Welcome/index.htm

IEEE Globecom 2014

WHEN: 8-12 December 2014

WHERE: Austin, Texas, USA

WHAT: The IEEE Global Communications Conference is an annual conference and industry forum on new research and technologies for the management of emerging networks and services. Globecom 2014 features tutorials and workshops on technical and business issues in communications technologies, as well as an exhibition showcasing the latest technologies, applications and services.

INFORMATION: www.ieee-globecom.org

EMC Compo 2014

WHEN: TBD

WHERE: TBD

WHAT: The 10th International Workshop EMC Compo 2014 is intended to be a place for researchers from industry and academia to exchange the latest achievements and experiences in integrated circuit-level EMC.

INFORMATION: www.emccompo2014.org

2014 IEEE International
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IEEE EMC SOCIETY

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The IEEE EMC Society seeks original, unpublished papers covering all aspects of electromagnetic compatibility, including EMC design, modeling, measurements and education.

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EMC Society will be offering Professional Development Hours, or PDHs

Members seeking PDH credit will have three options:

8 PDHs will be offered for:

(1) full attendance Monday at the Fundamentals of EMC Tutorial, or

(2) the Friday Fundamentals of Signal and Power Integrity and the Advanced Topics in Signal and Power Integrity Tutorials or

(3) receive 24 PDHs for attendance to the Symposium, Tuesday through Thursday

NEW FOR 2014
2014 IEEE International Conference on Signal and Power Integrity
SIPI-2014

This year's symposium includes an embedded conference,

2014 IEEE International Conference on Signal and Power Integrity (SIPI 2014),

featuring workshop, tutorials and technical sessions devoted to topics of interest to both EMC and Signal Integrity engineers.

For complete event details and information about paper submissions go to

www.emc2014.org

EXHIBITION - CONFERENCES - ANIMATIONS

Microwave & RF

3rd edition

The trade show dedicated to radiofrequencies, microwaves, wireless and fibre optics



19 & 20, March 2014
CNIT - Paris la Défense

Organization

BIRP

www.microwave-rf.com

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8th Annual International Electrostatic Discharge Workshop (IEW)

May 19-22, 2014

Grand Hotel de Paris, Villard de Lans, France

esda.org/IEW.htm

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September 7-14, 2014

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32 ARTICLES

Understanding EMC Basics: Waveforms, Spectra, Coupling, Overview of Emissions
KEITH ARMSTRONG, Principal EMC Consultant, Cherry Clough Consultants Ltd.

Analysis of Shielding Effectiveness of Board Level Shielding with Apertures
BRIAN SHE, EMC Engineer, Laird Technologies

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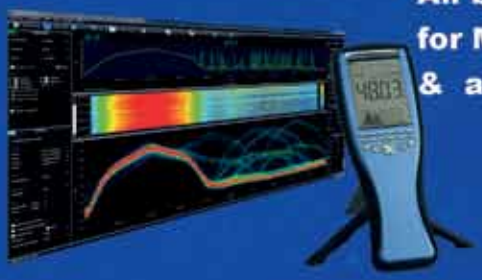
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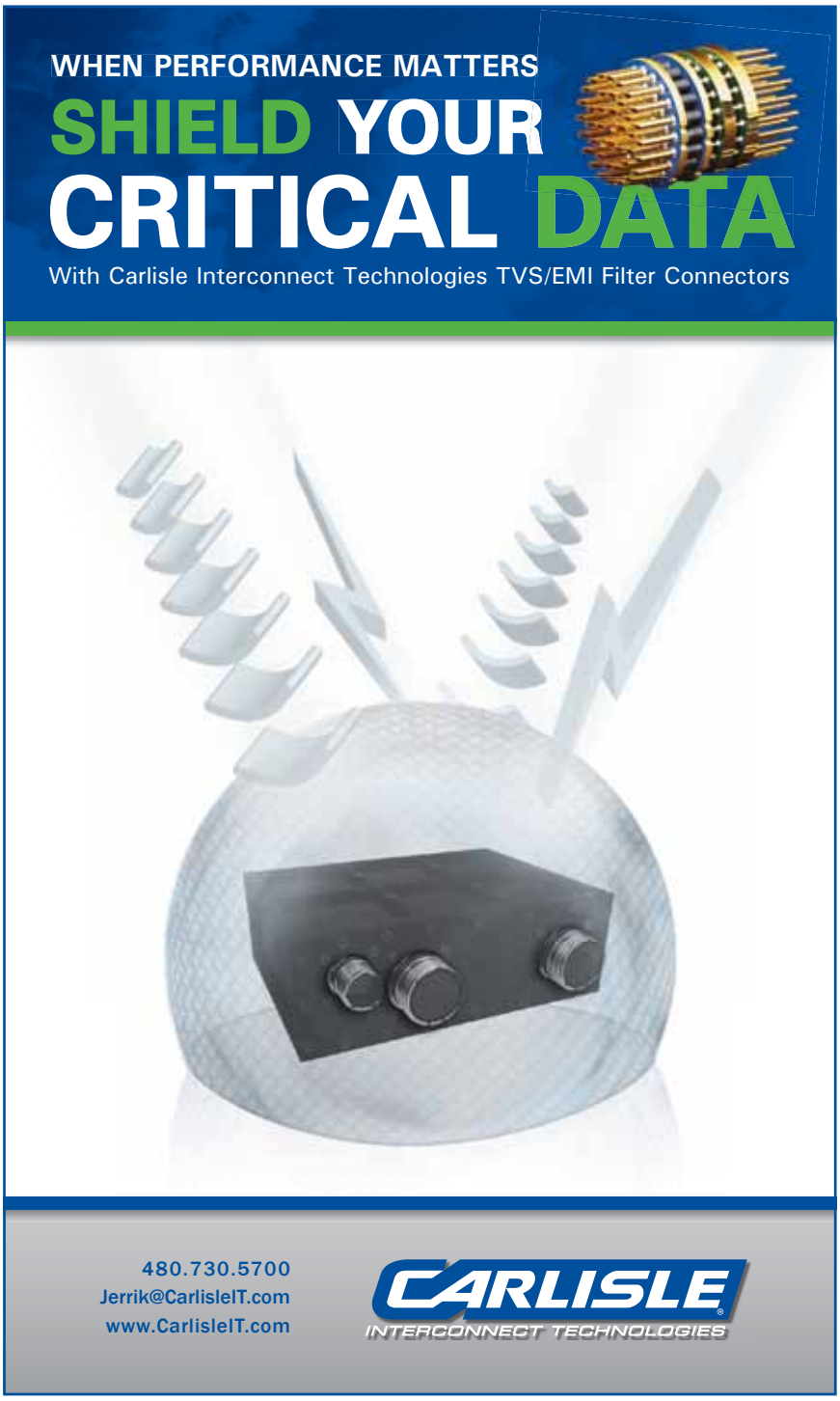
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Understanding EMC Basics: Waveforms, Spectra, Coupling, Overview of Emissions

KEITH ARMSTRONG
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Note: The following are questions asked in response to Keith Armstrong's Interference Technology webinar, 'Understanding EMC Basics 2: Waveforms, Spectra, Coupling, Overview of Emissions' which took place May 29, 2013. To view this webinar, visit www.interferencetechnology.com.

Q: COULD YOU SHOW THE PATH OF THE 310UA CURRENT THROUGH THE VICTIM (E-FIELD COUPLING)?

A: Good question, because being able to accurately visualise where the stray current flows is an important part of the skills we need to develop to be effective EMC engineers!

Unfortunately it is impossible to say where this stray current will flow, because it depends on all of the physical details of each specific situation – and the sketches that I used in my PPT slides didn't include sufficient information.

For example, the victim circuit that I drew could be connected to the same power and ground rails as the source circuit; or it could be powered completely separately and only share the same chassis as the source circuit, or it could be completely floating – unconnected to the source circuit. These three different situations could easily have very different stray return current paths from each other.

However, we do know, from EMC Physics (i.e. Maxwell's equations) that the stray current will preferentially flow through paths that result in the least magnetic field energy – and these will be the paths with the lowest overall impedance.

These paths could be along any conductors or through the air (i.e. via stray capacitance once again) – whatever returns the stray current to its original source with the least field energy.

It takes a full-wave field solver computer simulator that is supplied with the complete three-dimensional structure and all the electrical parameters of the materials used, to fully analyse where stray currents will prefer to flow.

Experienced EMC design engineers are – to some degree anyway – generally able to visualise the strongest paths taken by stray currents, but they have to beware of structural resonances that can what appears to be an important low-impedance path have a very high-impedance instead, and can make what appears to be a negligible (high-impedance) current path actually have a very low impedance instead – at certain specific frequencies.

To help with determining the actual stray current path,

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we generally use a range of diagnostic tools such as close-field probes, clip-on ferrite chokes, copper tape with conductive adhesive, etc., etc.

Of course, if we happen to have a complete 3-D characterisation of the situation and know what the various materials are (as we do (or should do!) in any competent product design project), and if we also have access to a full-wave field solver and know how to drive it – we can let the computer work it all out for us!

Suitable field solvers are very costly items, but the time they save in design, development, compliance, and getting to market usually makes it possible to justify their cost on the basis of a payback on the first project they are used on! Financial managers cannot resist such arguments; if they are presented correctly (I have an article on how to do that, if you want).

Q: HOW DO WE IDENTIFY TO BE DOMINANT BETWEEN E-FACTOR AND H_FACTOR?

A: In any circuit, if we measure the voltage of the noise it has picked up from its electromagnetic environment, we can then load the circuit with a low value of shunt resistance (e.g. 1kilohm or less, as low as the circuit will stand and still operate correctly) and re-measure the noise.

If loading the circuit reduces the noise voltage, it generally means E-field (stray capacitance) noise coupling is the dominant mode.

But if the noise voltage stays the same despite the circuit loading, then it generally means H-field (stray mutual inductance) noise coupling is the dominant mode.

It is not unusual to find that E-field coupling is dominant for some frequencies, and H-field coupling is dominant for others.

Series CM chokes work best at suppressing H-field coupled noise, whereas shunt capacitors work best at suppressing E-field coupled noise. So we sometimes find that types of suppression are needed – but beware of adding a shunt capacitor suppressor to any output signal that has DM RF content (e.g. digital waveforms with fast edges). Such capacitors generally need to add a series resistor or choke as well, to limit the RF current that the output can drive into the capacitor.

It should be possible to use a shunt capacitor that has low impedance at the frequency of the noise (instead of a shunt resistor) but I've never tried this. It might have some advantages for some circuits which don't like being loaded heavily by resistors, when the noise frequency is much higher than the signal frequencies in the circuit.

Q: YOU TALKED OF METAL PLANES. HOW DOES THE METAL MATERIAL AFFECT E AND H SHIELDING AS A FUNCTION OF FREQUENCY? 50 AND 60 HZ ARE A PROBLEM AREA. IS IRON THE BEST SHIELD FOR THAT FREQUENCY?

A: Yes, the type of metal can be very important for shielding, especially at low frequencies.

Above 1MHz or so the skin depth is so small that any metal thicker than 1mm gives wonderful shielding – usually severely

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limited by its gaps, holes, joints, and conductor penetrations.

But at low frequencies where the skin depth is more than half the thickness of the metal, ferromagnetism becomes very important for shielding magnetic fields. Iron is certainly a good material for 50 and 60Hz, but even so will need to be quite thick (several mm) to be very effective.

Of course, iron quickly rusts and isn't very strong, so we generally use mild steel with a protective layer of zinc or tin, which isn't as good as pure iron for shielding low frequencies – but it's always a trade-off in the end, and achieving high levels of 'passive' shielding at such low frequencies requires large thicknesses of steel or iron.

However, special alloys, such as Mumetal™ and RadioMetal™ have been developed specifically for good low-frequency magnetic shielding without requiring large thicknesses. They have relative permeabilities measured in the thousands, sometimes tens of thousands (mild steel is a few hundred, depending on its composition). Some types can require special handling techniques.

Strong fields can easily saturate these special alloys, so it is not unusual to find a layer of steel (which is hard to saturate) followed by a layer of MuMetal.™ Some specialist magnetic field shielding companies use proprietary triple-layer shielding, each layer being a different metal or alloy.

At low frequencies, electric fields are easily shielded even by thin metal foil, as long as it has a very highly conductive surface, such as tin plate.

Q: PLANES NEED TO BE GROUNDED TO SOMETHING?

A: It depends on what is meant by the word "grounded", because there is an awful lot of general confusion associated with issues of grounding/earthing.

As my slides said, metal planes are valuable as "image planes" – providing shielding benefits even if electrically isolated from the circuits they are protecting.

And – as my slides said – using them as current return paths for DM currents provides additional EMC benefits, which usually (but not always) means they are connected to the 0V DC power rail.

And also – as my slides said – using them as return paths for CM currents helps provide low-impedance local paths for these strays, again providing EMC benefits.

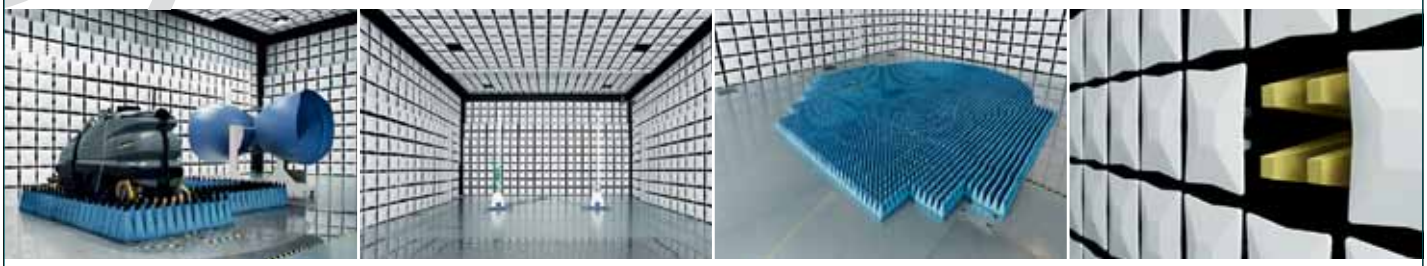
All of the above EMC benefits are only obtained when the metal plane is much closer to the circuits concerned than one-tenth of the wavelength at the highest frequency that we wish to control for emissions or immunity. Preferably closer than one-hundredth of the wavelength, e.g. < 3mm for up to 1GHz.

Notice that none of the above have any requirement for "grounding" to a safety ground electrode. I can't answer any better than the above because the question does not say what it means by the phrase "grounded to something".

For many decades there have been many huge myths surrounding the word "ground", both in circuit design and EMC design, which I tried to dispel in my webinar.

When an electrical safety engineer talks about grounding

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he or she means a low-series-resistance (usually < 1 Ohm) connection to the electrodes in the ground – the soil on which the building or railway line sits – which is also connected to the neutral of the secondary of the mains power supply HV distribution transformer that supplies the building or railway line.

The aim is for any insulation failures in the mains wiring to result in a current flow into the ground that is so high (because of the low-resistance grounding network) that fuses or circuit-breakers in the mains supply's phases open very quickly to reduce exposure of personnel to electric shock risks, and also so that the energy released in the fault is insufficient to cause a fire or explosion (or, in high-power systems, to limit the energy released in the fault to that which can be safely contained by the enclosure).

When a lightning protection engineer talks about grounding, he or she means a low-series-impedance (usually < 1 Ohm) connection to the electrodes in the ground (i.e. the soil).

Notice that this is not the same as the electrical safety engineer's grounding requirements. The electrical safety engineer is only concerned with 60Hz (or 50Hz in some countries, or 400Hz in some parts of aircraft, or 16.67Hz in some railway systems) – and so he or she only needs low resistance, which can be achieved by long wires if they have sufficient cross sectional area.

But the lightning protection engineer has to deal with lighting surge currents, the energy spectrum of which is generally considered to peak at around 10kHz and extend up to about 10MHz. Any wires or braid straps longer than about 500mm have too much inductance to achieve the low-impedance required for surge suppression, so he or she must use other metal structures, usually interconnected in some form of mesh, to be able to control lighting surges as their currents are routed back to the soil from which they originally came (in the form of lightning bolts).

When a static-control engineer talks about grounding, he or she means a reliable conductive connection of any sort to the safety grounding structure of a building – and sometimes they will prefer 'grounding' connections that have very high series resistance, such as 1 Megohm.

When a circuit design engineer talks about grounding, he or she means a very low-impedance DC power supply rail that is common to one or more circuits.

This is usually the 0V rail or plane, and it does not need to be electrically connected to the safety ground for the circuits to work fully to specification (otherwise, how could cellphones, iPods, laptop PCs, cars, aircraft, etc. possibly work?).

When an EMC engineer talks about grounding, he or she means providing a low-impedance path for a stray current to quickly and easily find its way back to its source, so that it doesn't cause excessive fields that cause interference with other circuits. This is usually provided by a chassis or enclosure metal structure, which generally needs connections to all of the DC power rails used by the circuits that have low impedances over the frequency range to be controlled.

Note that "EMC grounding" does not need to be directly electrically connected to any DC rails (power or 0V), and does not need to be connected to the safety ground at all, to function fully.

The confusion and myths over the word "grounding" has arisen because it is common for all of the above five quite different "grounding" requirements to be met by the same metal structure – the chassis or enclosure metalwork that is connected to the electrical safety "grounding" network that is meshed to provide the lightning protection's "grounding" network, and which is also connected to the electronic's 0V DC power rail.

This fact has unfortunately led to people imagining that the connection to the safety ground electrodes in the soil are somehow important for a circuit to work, or for EMC mitigation techniques to work.

It has also unfortunately led to people imagining that – like the DC currents that flow from the DC rail to the 0V rail – AC currents (including stray RF noise currents) also flow 'downhill' to the 0V rail.

In fact, all AC currents at whatever frequency – and whether they are DM or CM – always flow preferentially in whatever paths they can find that have the lowest impedance, even if that means through stray capacitance in the air, or stray capacitance through an insulator!

But the functions of all these five different types of "grounds" are very different, so it obviously causes confusion to use the same term for each. This very confusion has cost many manufacturers very dearly, over several decades, in unnecessarily high development costs and time-to-market delays, and unnecessarily



high costs-of-manufacture.

So I always strongly recommend never using the word "ground" (or "grounding" or "grounded") at all, except when concerned with the electrical safety of mains-powered equipment.

Q: IF THE MAINS LEAD POSITIVE AND NEGATIVE ARE BALANCED WRT TO 'GROUND' DOES THIS REDUCE CM NOISE ?

A: I assume 'positive' and 'negative' mean live and neutral, or Phase 1 and Phase 2 in the case that the neutral is a centre-tap in the distribution transformer's secondary winding so both wires are 'live' (e.g. in the USA 220V mains is supplied in domestic premises as ±110V).

Yes, balancing the live and neutral (or phase 1 and phase 2) to ground helps to reduce the CM noise emissions from the mains cable but only for the DM currents flowing in that cable. Essentially, it helps prevent DM to CM conversion in the cable.

But it's not a trivial thing to achieve balanced impedances on the live and neutral, or three phase, leads, over a wide frequency range. Careful, regular twisting of the wires is good up to 1MHz or so, but mains cables aren't made carefully enough in general for higher frequencies so we often find ourselves having to clip large ferrite CM chokes onto the cable at the equipment end. Sometimes it is even necessary to space several ferrite chokes along the length of the cable as well!

It is important to note that having live and neutral (or phase 1 and phase 2) wires that are well-balanced around the safety ground wire, will do nothing for any CM currents flowing in the mains cable.

These CM currents could be caused, for instance, by inadequate shielding of an electronic product that allowed stray currents to flow out of its PCBs or from its heatsinks into the floor, walls, ceiling of a room or into any people or other equipment in that room. These strays currents mostly return to the circuits that "lost" them via cables, especially the mains cable, flowing equally on all of the wires in these cables – for example on the live, neutral and safety ground wires in the mains cable).

If these cables are shielded, the stray CM return currents will just flow on the outsides of their shields. It is possible to reduce some frequencies to some degree by fitting CM chokes, which is why during the process of suppressing emissions that are over the limit, we often find ourselves with two (or more!) clip-on ferrite CM chokes on every cable that connects to the unit concerned!

Because no-one likes to buy products that have their own weight in ferrite chokes clipped to all their cables, a more practical solution to this specific example of a CM current problem, is to reduce the stray capacitance radiated emissions from the unit, by better circuit design, better PCB design, better internal cabling design, and better shielding. (To reduce costs, these days most manufacturers use PCB-mounted shielding instead of enclosure shielding.)

Notice that all of these solutions require more in-depth design iteration than just throwing filtering and shielding at a unit that fails its EMC tests – which is why it is very important indeed, to help avoid financial risks (this is the only kind of language our bosses understand) to design EMC in from the start of a project – and not leave it until a new products is failing its compliance tests!

There are many other possible causes of stray CM currents, e.g. inadequate filtering and/or shielding of signal/control/data cables, poor PCB layout, poor choice of ICs, poor design of heatsinks, etc., etc.

Q: WHAT ARE BEST PRACTICES FOR QUALIFICATION OF HOMEMADE ANTENNAE TO 'CALIBRATE' PRE-COMPLIANCE MEASUREMENTS?

A: Apart from 'sniffer' probe antennas, I have always used antennas that I have purchased, complete with calibration charts from laboratories that are accredited to calibrate antennas.

One antenna that I use a lot is the York EMC "Active Receive Antenna, model number ARA01" – which covers the same frequency range as a traditional 'bilog' (30 to 1000MHz) with comparable antenna factors, but (unlike a bilog) is small, lightweight, and much more portable and easy to use, visit http://www.yorkemc.co.uk/instrumentation/ara01.

However, it is possible to purchase calibrated "RF noise generators" – that go by a variety of marketing names – and use them as "transfer calibrators" for your own antennas. They are all small and portable, and battery-powered, and have been tested on a proper antenna calibration site to give a graph of their emissions versus frequency when measured perfectly.

Examples include:

"Comparison Noise Emitters" up to 40GHz, from York EMC: http://www.yorkemc.co.uk/instrumentation/cneiii

"Reference Sources" from Laplace Instruments: http://www.laplace.co.uk/products/15/

"Universal Spherical Dipole Source (USDS)" from Applied Electromagnetic Technology LLC:

http://appliedemtech.com/usdsmain.html

"Comb Generators" from Com-Power Corp.: http://www.com-power.com/comb_generators.html

Of course, an antenna doesn't exist in isolation – it is always affected by its surroundings, the emissions test site.

So we should calibrate our antennas in the exact site where we intend to use them to make emissions measurements – ideally making the structures of those sites as close as we can to the design of the test site that is specified in the relevant emissions test standard.

Another use for these portable RF noise generators is when testing a large system or installation on the factory floor, or in-situ after commissioning. They allow us to compensate not only for the deficiencies in our homemade antennas, but also for the deficiencies in the site itself.

This question addresses the issue that the sensitivity of our home-made antennas varies with frequency, so must be compensated for by calibrating them to obtain the antenna correction factors (usually just called Antenna Factors) that we have to add to our 'raw' emissions measurements to be able to compare them with the limits in the standards.

But we must beware – a problem with home-made antennas can be very poor sensitivity at some frequencies, requiring large antenna factors that can make the measurement noise floor get very close to, or even exceed the limit line at those frequencies!

So perhaps it is best to purchase low-cost antennas specifically designed for pre-compliance testing. I'm sure there are several companies offering such products, but the only one I know of is Laplace Instruments in the UK, visit http://www.laplace.co.uk, who have been adding to their excellent range of pre-compliance emissions and immunity products for 20 years.

Analysis of Shielding Effectiveness of Board Level Shielding with Apertures

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ABSTRACT

THERE IS A GROWING need to evaluate the shielding effectiveness (SE) of board level shielding (BLS). By means of a reverberation chamber, we performed a series of shielding effectiveness test for board level shielding products with different apertures. In addition, an analytical SE formulation has been developed in comparison with the SE measurement result.

Key words— Apertures, Shielding effectiveness, Board level shielding, SE calculation

INTRODUCTION

In the electromagnetic shielding practice, board level shielding is widely used for isolating electromagnetic interference, especially on the circuit board with intentional RF emission. A perfect BLS will have no apertures and fully be soldered on the ground plane of the board all around its perimeter, so that it can reach the maximum shielding effectiveness. However, we need to make the BLS lighter weight, more convenient manufacturability, and we also have to avoid cavity resonance inside the BLS, dissipate the heat and let microstrip trace to go through, so there should be several apertures opened on the BLS, to evaluate the effect of apertures on shielding effectiveness, we performed several kinds of test on different apertures for comparison, and we also run some calculation tools to plot the corresponding SE data based on shielding theory.

SHIELDING THEORY OF MATERIAL WITH APERTURES

Shielding Effectiveness (SE) measurement of materials is a comparable method to evaluate the shielding performance, the current universal method used for obtaining a value for the SE is to measure difference between the received power with and without the shielding parts assembled, the equation expressed in dB is:

$$SE = 10\log_{10}\left(\frac{P_1}{P_2}\right)$$

Where:
P_1 =the received power without shielding;
P_2 = received power with shielding;

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The shielding effectiveness of an aperture, and ultimately of the enclosure itself, is a function of its size, shape and number of apertures .The worst-case shielding effectiveness of the slot (L) based on the radiation efficiency of a slot antenna, provides a simple model for calculating the worst-case shielding effectiveness of an aperture. A different value of constant (k) is for a slot (20) or for a round hole (40). A slot can be considered to have a length-to-width ration of 4:1 or greater. For geometrically even holes such as squares or hexagons, 40 may be used as the constant.

Shielding effectiveness of a single aperture with the largest dimension of the opening length (L) is given by:

$$SE = 10\log_{10}\left(\frac{\lambda}{2L}\right)$$

Where:
λ = wavelength
k = 20 for a slot or 40 for a round hole
L = largest dimension of the aperture which is ≤ λ/2

For more than one aperture, the SE must be subtracted by 20 log10 of the total numbers of apertures within a half wavelength, so updated equation is:

$$SE = k\log_{10}\left(\frac{\lambda}{2L}\right) - 20\log_{10}n$$

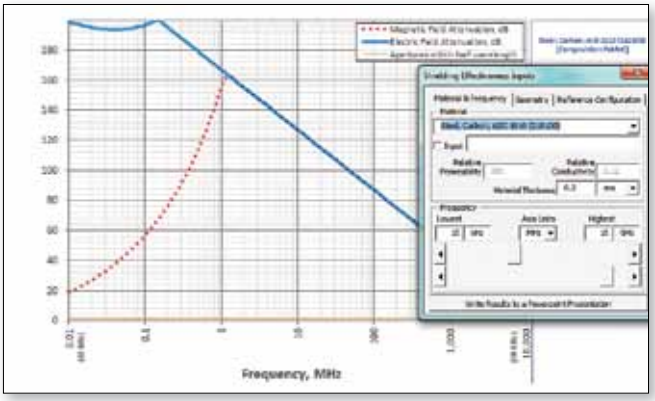


FIGURE 1: an example of the Aperture Attenuation Modeling Program

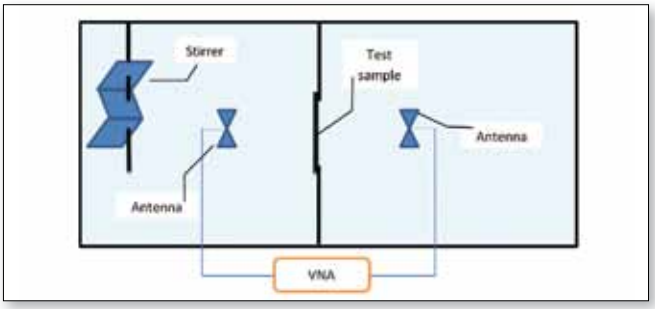
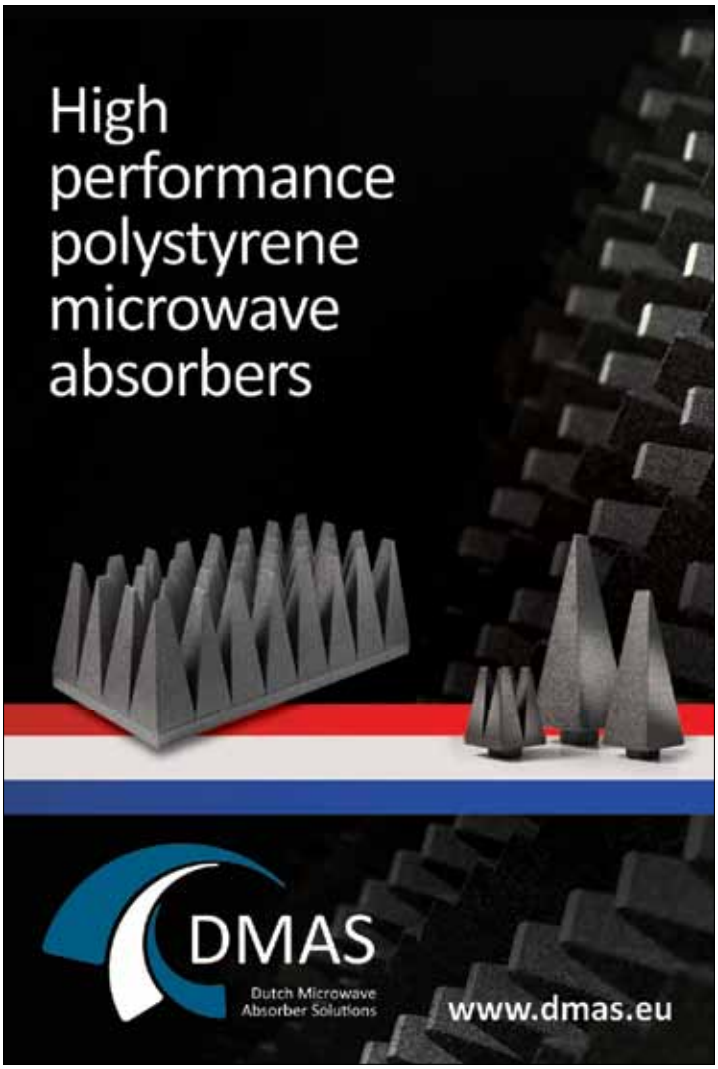


FIGURE 2: SE measurement set-up in a reverberation chamber



Where:
n = numbers of apertures within a half wavelength

Theoretically, Apertures placed more than half a wavelength apart do not in general worsen the SE value, but half a wavelength at most concerned frequencies is usually big enough for the actual spacing between apertures on board level shield.

This equation is based on slot antennas under free space plane-wave propagation i.e. far-field conditions when the wave impedance in air is (120π) Ohms, while for many cases in real practice, the BLS is located in near-field of the source at certain frequencies, and the SE may be worsen in this condition, so we should state here that one should consider the distance from the aperture to the radiation source when using this SE calculation formula.

SE CALCULATION FOR APERTURES

Based on the before-mentioned equations, we developed a modeling program (Microsoft Excel format) for the calculation of shielding effectiveness resulting from apertures (holes and/or slots) in printed circuit board shields or other enclosures, The program provides an estimate of the resultant shielding effectiveness due to ventilation holes needed for heat management or folded metal that form slots on the sides of a board level shield.

In the shielding effectiveness input box, several input options should be selected, the main input section is the maximum dimension of the aperture, which will determine most of the level of SE, to elaborate the apertures, we also need to decide the following items:

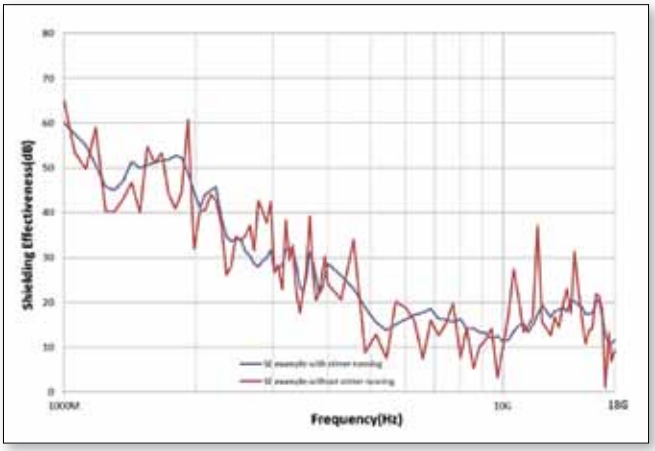


FIGURE 3: SE examples-with and without stirrer running

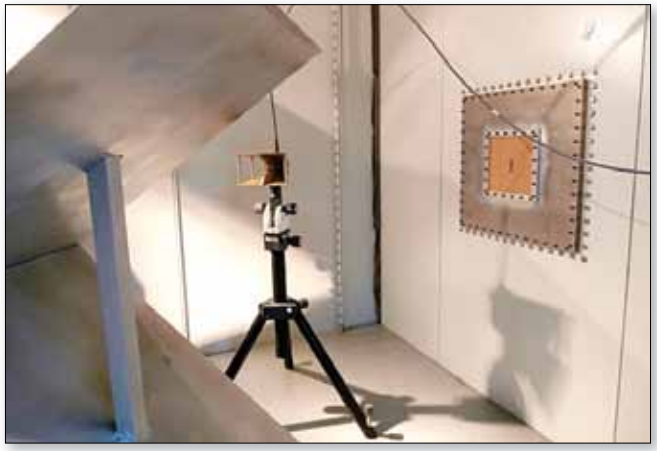


FIGURE 4: Test set-up in transmitting room



FIGURE 5: Test set-up in receiving room

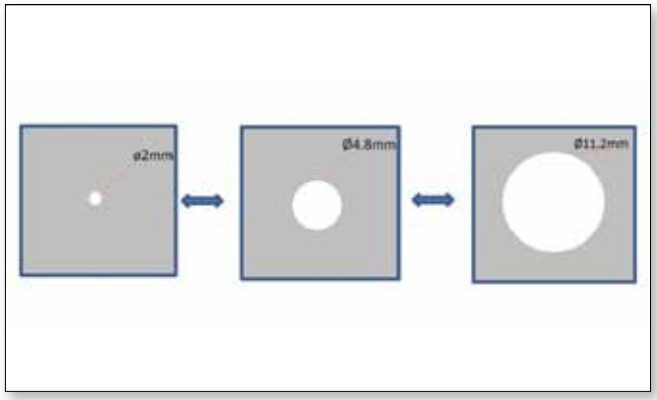


FIGURE 6: Apertures of round holes of ø2mm & 4.8mm & 11.2mm

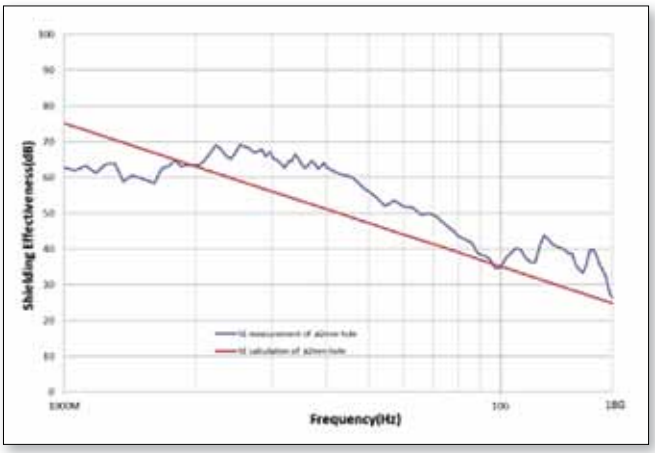


FIGURE 7: SE of a ø2mm hole

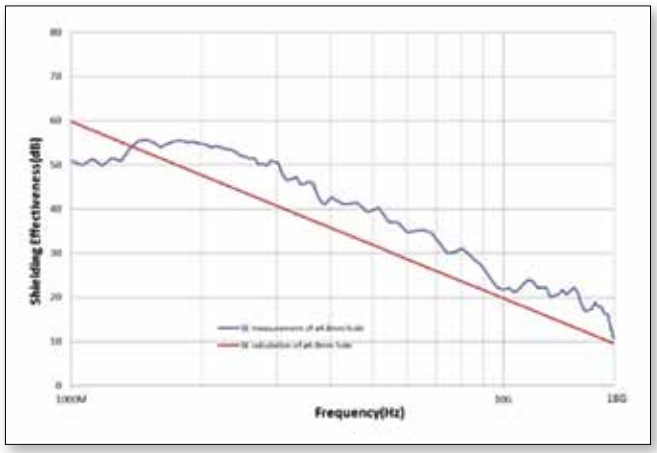


FIGURE 8: SE of a ø4.8mm hole

A, whether the emitter is inside or outside of the shield: the SE calculation formulas are different under these two conditions because the reflection portion needn't be considered if the emitter is outside.

B, the spacing between apertures: the numbers of apertures within a half wavelength N will be figured out by this input.

C, correction factors such as the shielding material (permeability and conductivity) and the aperture shape (it is more round or more slot-like.).

SE MEASUREMENT IN A REVERBERATION CHAMBER

A Radiated Shielding Effectiveness testing was performed in a reverberation chamber. The chamber has metallic, highly electrically reflective walls, which, in conjunction with a mode stirring paddle to produce statistically uniform internal electromagnetic fields. The mode stirrer was installed in the room with transmitting antenna, and the receiving antenna was placed in another shielding room, the test sample was mounted on a shielding wall to separate the two antennas. An overview of this test set-up is shown in Figure 2.

The above setup diagram just describes the main structure of the test, to achieve sufficient dynamic range, we also adopted

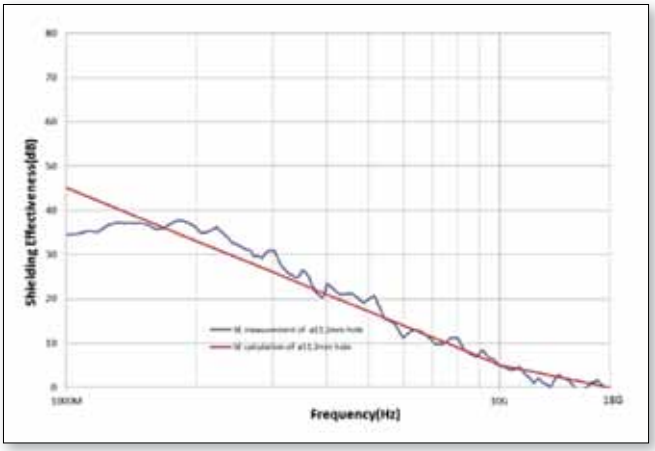


FIGURE 9: SE of a ø11.2mm hole

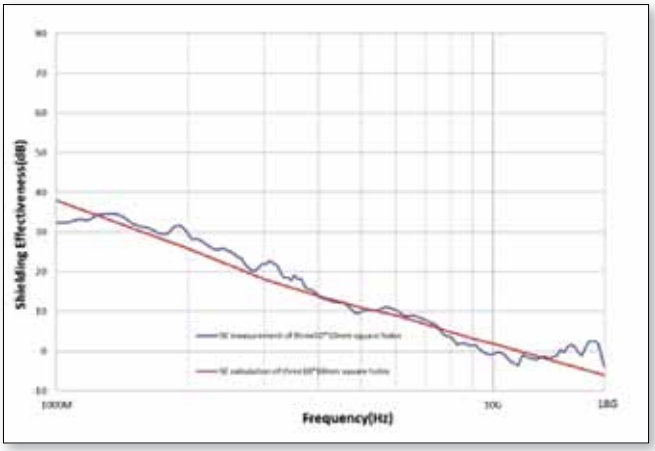


FIGURE 12: SE of three 10mm*10mm square holes

power amplifier in the circuit loop, as well as the low noise preamplifiers.

For the SE test in a reverberation chamber, we need to run the mode stirrer to create a uniform EM environment in the transmitting room, in such condition, the time-averaged fields (or power density) inside such a chamber are approximately equal in amplitude. To evaluate the performance of the mode stirring system, we tested SE with and without the stirrer running, Figure 3 is an SE example for BLS testing, it shows that the data curve is more fluctuated when testing without stirrer running.

The test sample is made of copper sheets as it is very conductive and it is easy to cut into different apertures. After the test sample is done, we mount it onto the test fixture by four aluminum clamps, and we also put conductive foam between the contact surfaces for better shielding. The antenna should be placed far enough so that the EM wave at the surface of the object is stable plane wave, here we placed the transmitting antenna pointed at the center of the paddle, which is about 1.5m away from the test sample. In the other enclosure, the receiving antenna was pointed directly at the test sample 50cm away, so that the most received energy is from the BLS aperture. The test frequency starts from 1GHz to 18GHz, thus, we can get the test data which is quite stable and repeatable. Figure 4 and Figure 5 shows the SE test set-up in the reverberation chamber.

DISCUSSION OF THE SE RESULT

To obtain relatively comparable test results, we built some

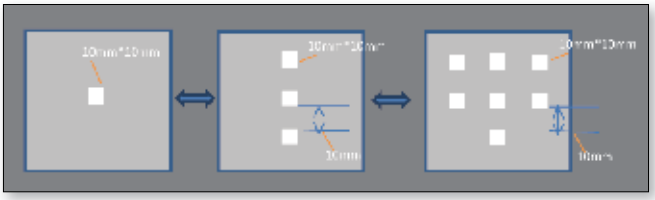


FIGURE 10: Apertures of one square hole VS. Three square holes in line VS. nine square holes in matrix

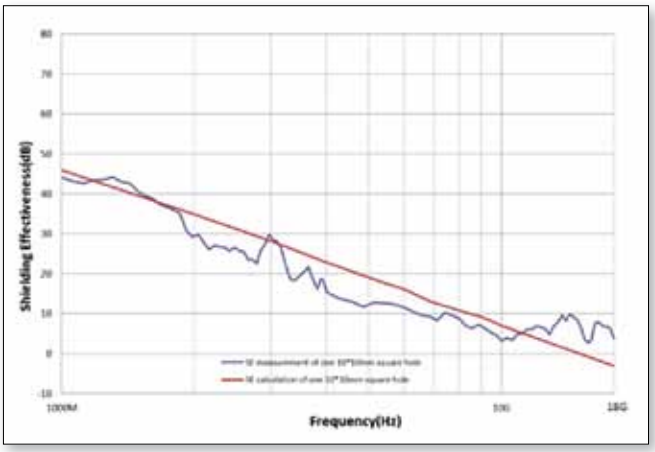


FIGURE 11: SE of one 10mm*10mm square hole

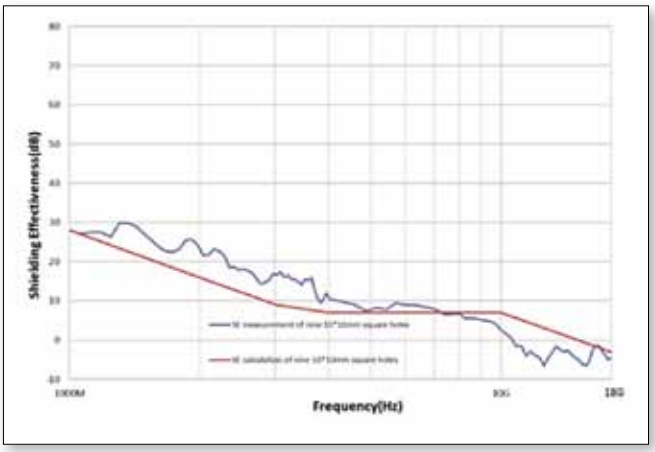


FIGURE 13: SE of nine 10mm*10mm square holes

specified dimensions of the test samples, including holes and slots. The following are some examples for SE comparison.

1, SE comparison between different dimensions of holes (Figure 6).

The SE results by both measurement and calculation are shown as below, Figure 7 to Figure 9 are the SE data of different sizes of round holes. First, as to the comparison of ø2mm, ø4.8mm and ø11.2mm holes, the SE between measurement and calculation are matched, although not very well, we can see that they have the same tendency, but in most frequencies, the calculated SE value is lower than the measured SE value, this is reasonable because the calculated SE always represents the worst case. If we look at the details of each figure, the measured SE at low frequencies is not as high as expected by calculation, the most possible reason for this mismatch is the methodologies difference between measurement and calculation, for SE calculation, the reference level is derived from an infinite large opening, while in real test, we use a specified opening to get the reference level, thus there are reflections should be considered

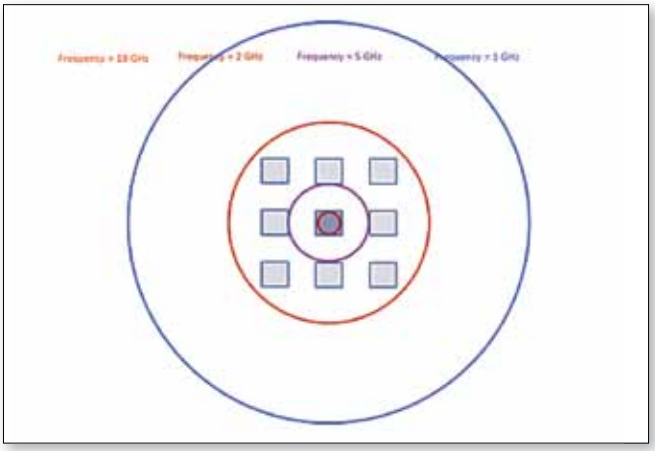


FIGURE 14: Apertures VS. Circle with Diameter of λ/2

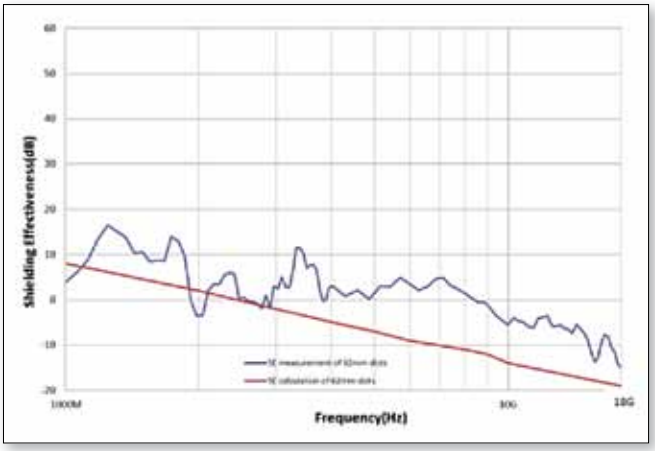


FIGURE 17: SE of a 62mm*4.8mm slot

in SE measurement.

2, SE comparison between different hole numbers (figure 10).

In real application, we usually use the BLS with several hole on it, so it is worthy to study how much effect of the numbers of apertures contribute on SE, figure 11, 12 and 13 are the SE of apertures with one hole, three holes in line and nine holes in matrix, each of the hole is 10mm*10mm in square shape.

Let's compare the SE differences between one hole, three holes and nine holes, firstly, there is about 10dB difference between them in lower frequency range, both in measurement and calculation. however, in higher frequencies(above 10GHz), the calculated SE values almost stay in the same level between this three, and the measured SE gaps also narrowed to about 5dB, so we see the whole SE curve become more flat when the hole number increases. According to the calculation formula, this is reasonable because the calculation factor "n" (which means the number of apertures with λ/2) will minimize to "1" as the frequency goes higher, thus, it implies that in higher frequencies, the apertures outside the "λ/2" circle area won't make effect on the SE value, Figure 14 is the Aperture Depiction, Showing Circles with Diameter of λ/2.

We see that SE could even go to negative in the foregoing example, It should be clear that an inefficient radiation source (e.g. an electrically small circuit) can become many orders of magnitude more efficient by coupling to a larger conducting structure. Therefore it is not only possible, but common, for

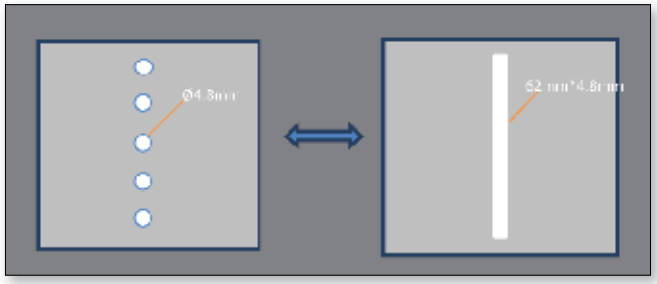


FIGURE 15: Apertures VS. Circle with Diameter of λ/2

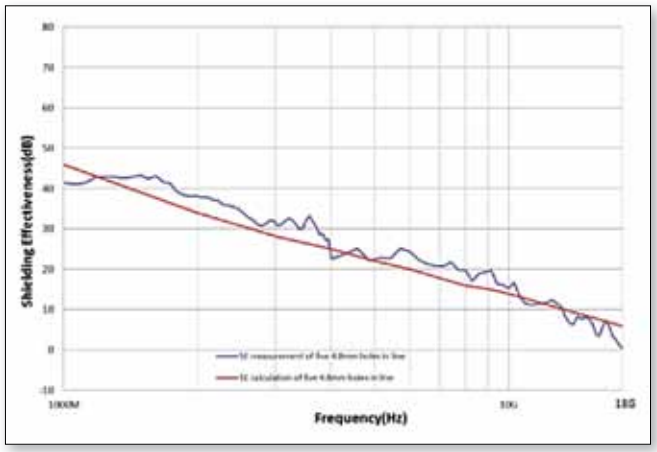


FIGURE 16: SE of ø4.8mm holes in line

a shielding enclosure with apertures to increase the radiated emissions due to the sources enclosed. In other words, the SE of a shielded enclosure can easily be less than 0 dB (i.e. the enclosure amplifies the radiation) at some frequencies. Therefore, it is not safe to assume that some shielding is better than no shielding.

3, SE comparison between holes in line and slot (figure 15).

In order to improve the shielding performance, we should study on SE of different type of apertures, the typical research is comparison of holes and slots, of which the SE data are shown in figure 16 and 17, the five ø4.8mm holes in line versus one 62mm*4.8mm slot, we compare them because they occupied similar area of the BLS, and we can see that there is big difference of SE between them (the SE of slot is about 40dB lower than the SE of holes), Please note that the polarized direction of incident wave is parallel to the long side of slot, so the test data is quite coincident with calculation. In design for EMC, it is important to divide a big aperture into several small one when design the BLS, and of course the round holes always perform the best SE compared to other apertures.

From all the SE data line above, we can say that generally, the SE data from calculation is in agreement with the measurement, although there are mismatch points at some frequencies. We know that SE test result may be influenced by many factors, such as chamber resonance, test set-ups, cable coupling etc., so it is meaningful to do comparison in different test labs by different test methods. In terms of the SE calculation formula, the biggest disadvantage is it is helpless for complex apertures, However, SE calculation is still widely used for comparison, such as varying aperture size, number, and/or spacing.

CONCLUSIONS

We discussed SE for different apertures of BLS by means of reverberation chamber testing, the SE between different apertures varies a lot, we see that the main factor is the hole dimension, and the shape (round or slot), hole numbers also make effect on SE. Meanwhile, we analyzed the SE calculation compared to the measurement, the data are proportional with the measurement result in the whole frequency although they are some dis-matched points, however, as the equation for SE calculation ignores some factors such as the variation of wave impedance, as well as the antenna direction and polarization, we don't suggest to do SE calculation for complicated aperture evaluation, but it is still reasonable for us to use the SE calculation tool to do comparison especially for far-field immunity concern.

REFERENCES

- [1] MIL-STD 285, Method of attenuation measurements for Electromagnetic Shielding Enclosures for Electronic Purposes, (1956)
- [2] Wojciech J. KRZYSZTOFIK, Robert BOROWIEC, Bartosz BIEDA, Some Consideration on Shielding Effectiveness Testing by means of the Nested Reverberation Chambers.
- [3] C.L. Holloway, D. A. Hill, M. Sandroni, J.M. Ladbury, J.Coder, G. Koepke, A.C. Marvin, Y.He "Use of Reverberation Chambers to Determine the Shielding Effectiveness of Physically Small, Electrically Large Enclosures and Cavities." IEEE Transactions on Electromagnetic Compatibility. (2008).
- [4] Frank B.J. Leferink, Hans Bergsma, Wim C. van Etten "Shielding Effectiveness Measurements using a Reverberation Chamber."
- [5] Martin Paul Robinson, Trevor M. Benson, Christos Christopoulos, John F. Dawson,
- M. D. Ganley, A. C. Marvin, S. J. Porter, and David W. P. Thomas, "Shielding Effectiveness Measurements using a Reverberation Chamber."

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The First Practical Approach to EMC for Functional Safety (EMC Risk Management)

KEITH ARMSTRONG
Principal EMC Consultant, Cherry Clough Consultants Ltd., Stafford, UK

THERE ARE NOW MANY STANDARDS on Functional Safety (Risk Management) that apply to relevant electronics, including IEC 61508 [1] and the standards developed from it listed in Section II of [2], and ISO 14971 [3].

They all require that EMI be dealt with, but complying with emissions and immunity EMC test standards, even using increased levels of immunity testing, has long been known to be insufficient for Functional Safety. Unfortunately, until now there has been no published alternative that provided a set of requirements and methods for assessing whether those requirements had been met.

By 2008 all of the guides, draft standards and IEC Technical Specifications (e.g. [4] [5]) on EMC for Functional Safety had assumed that – if big, heavy, costly 'grey shielded boxes' were not used – this could be dealt with by being clever enough in the EMC design, and in its verification and validation.

However, a number of companies tried to put this 'Clever EMC' approach into practise, and found that it was impractical for several reasons (described in [2] [6]). Discussions with these companies and other functional safety practitioners revealed an alternative, practical approach that used well-proven hardware and software design 'techniques and measures' (T&Ms) plus independent assessment.

Converting the initial concepts into a document that was accepted widely enough for the IET to publish [7] required a great deal of work by EMC experts and Functional Safety experts in the IET's Working Group. It also involved over 160 high-quality comments on its first draft from a very wide range of experts in Functional Safety and EMC, including UK Government Safety Regulators.

This new approach has three parts, shown in Figure 1.

Unusual or extreme electromagnetic disturbances that exceed the protection achieved by compliance with immunity test standards, will cause EMI in the equipment. This EMI will cause errors, malfunctions or failures in the equipment's signals and/or power supplies.

Since 2000, IEC 61508 [1] has recommended many dozens of well-proven T&Ms for system, hardware, software, and power supply design for detecting and/or recovering from errors, malfunctions or failures in signals and power supplies.

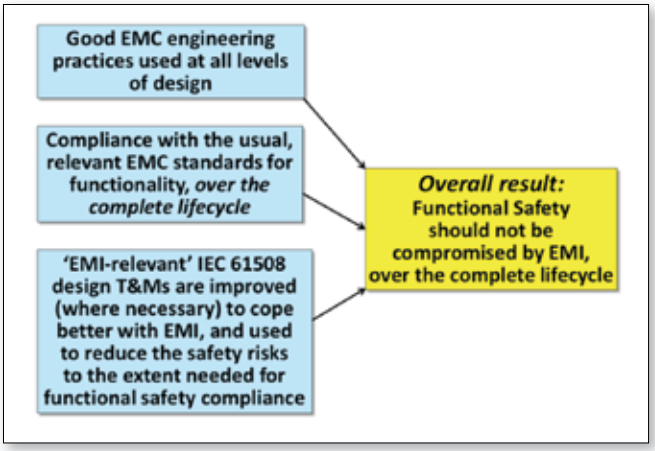


FIGURE 1: Overview of the approach taken by the new IET guide

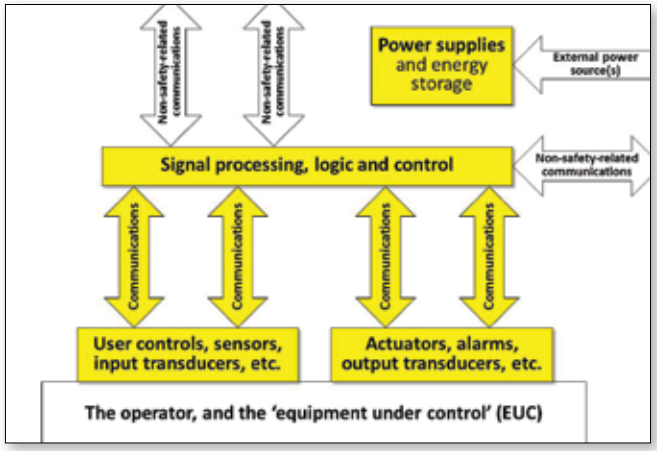


FIGURE 2: Overview of a safety related system and its constituent parts (in the yellow boxes)

An industry has grown up around the use of these T&Ms to comply with Functional Safety requirements, both in design and its independent assessment. All of the global safety approvals bodies (Intertek, TÜV Rheinland/Nord/Süd, SGS, and many others) offer assessment services, and if an independent assessor does not approve a design, it is not permitted to be sold or deployed.

The IET's new guide recommends IEC 61508's T&Ms that are especially effective for dealing with EMI, in some cases recommending ways of using them to enhance their effectiveness.

To use the IET's new guide, EMC engineers need to design and construct equipment that will continue to comply with their relevant EMC test standards throughout their lifetimes in their real environments (not just when they are new and in an EMC laboratory).

And designers and independent assessors in the Functional Safety world need to apply the T&Ms they already know very well in slightly different ways so that EMI should not cause unacceptable risks over the lifetime of the equipment.

The IET's new guidelines [7] can be applied to complete safety-related systems, or to any parts of them, as shown in Figure 2. For example, some parts of a safety system could use the traditional 'big grey box' approach, while others use [7]'s T&Ms.

REFERENCES

- [1] IEC 61508 Ed.2:2010, "Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems", IEC basic safety publication in seven parts.
- [2] Keith Armstrong, "Cost-effective Risk Management of EMC without special EMC design expertise or testing", IEEE 2013 Int'l EMC Symp., Denver, CO, USA, August 5-9, 2013, ISBN: 978-1-4799-0409-9
- [3] ISO 14971 "Application of risk management to medical devices"
- [4] IEC TS 61000-1-2, Ed.2.0, 2008-11, "Methodology for the achievement of the functional safety of electrical and electronic equipment with regard to electromagnetic phenomena", IEC basic safety publication.
- [5] The IET, "EMC for Functional Safety", Aug. 2008, from www.theiet.org/factfiles/emc/emc-factfile.cfm, or www.emcacademy.org/books.asp
- [6] Keith Armstrong, "The first practical techniques for achieving EMC for Functional Safety (without using big grey boxes)", The EMC Journal, Issue 108, September 2013, www.theemcjournal.com
- [7] The IET, "Overview of techniques and measures related to EMC and Functional Safety", August 2013, free download: www.theiet.org/factfiles/emc/emc-overview.cfm.



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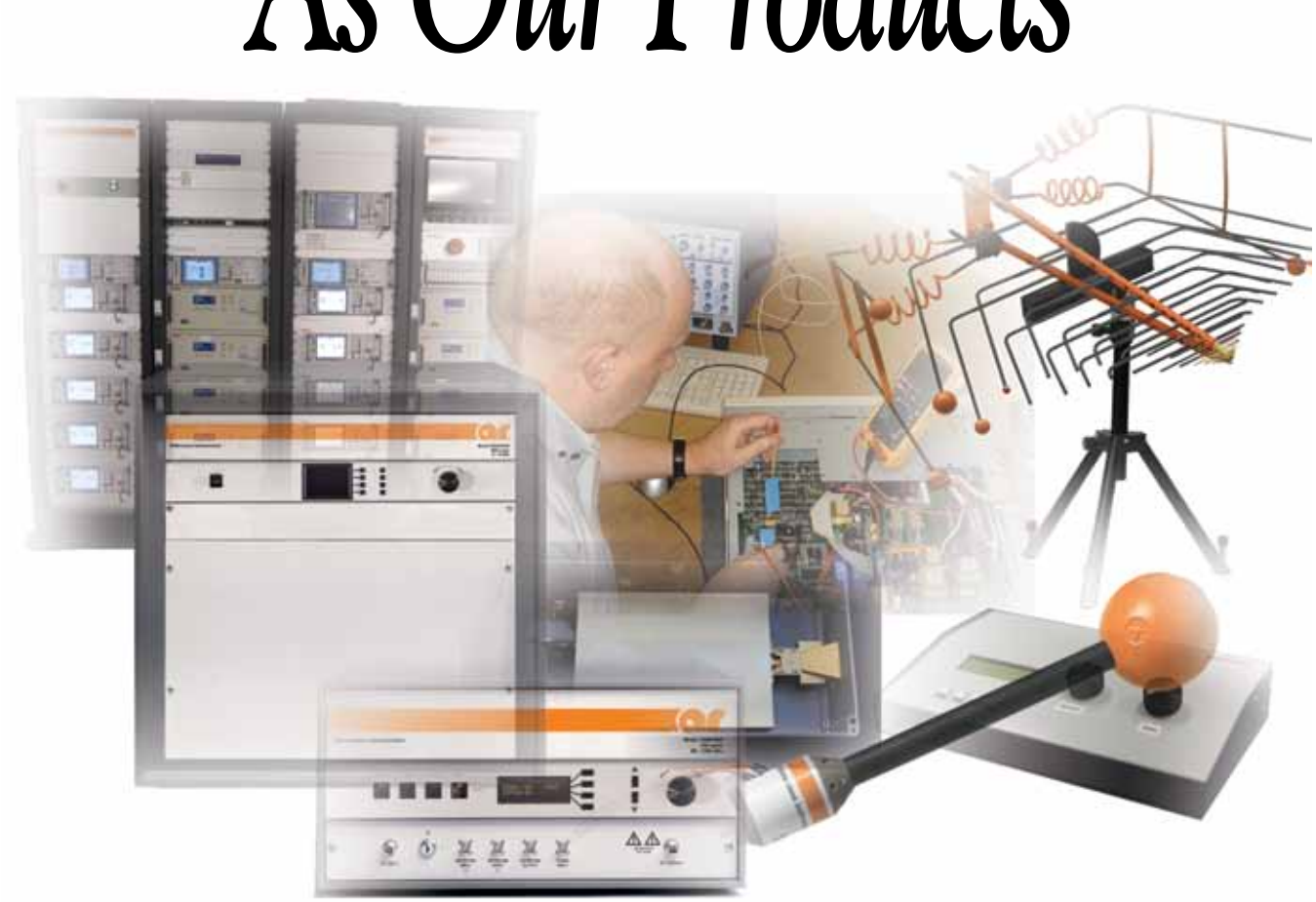
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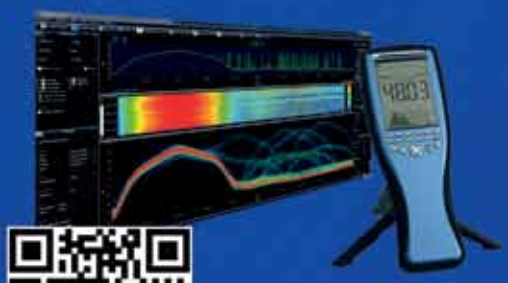






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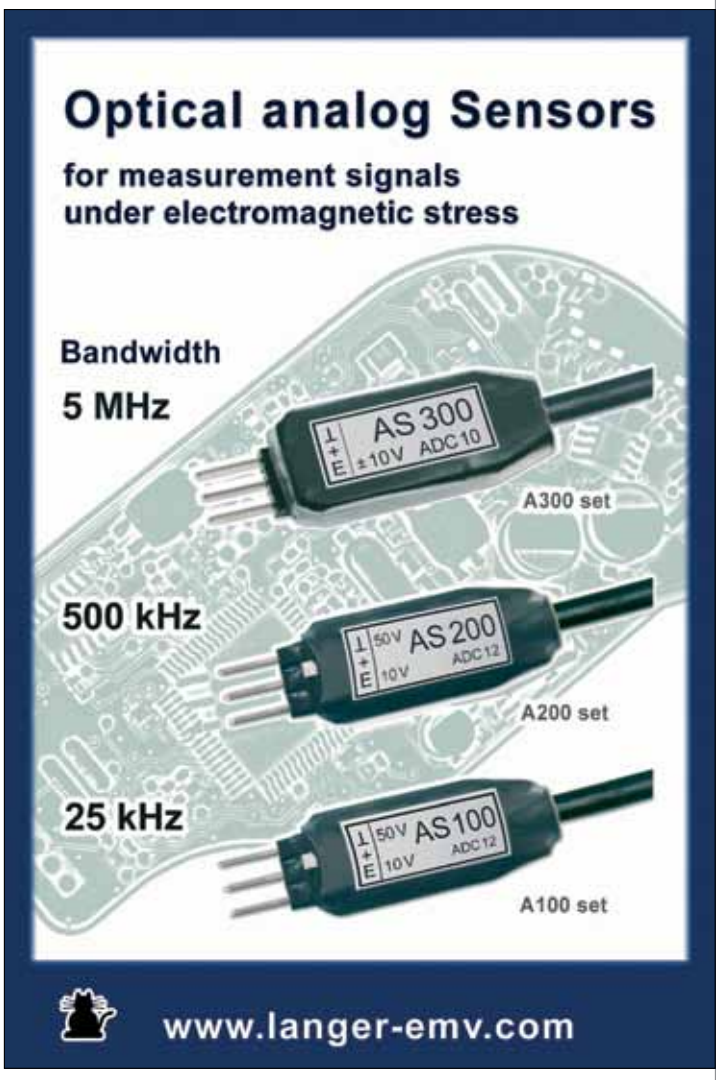
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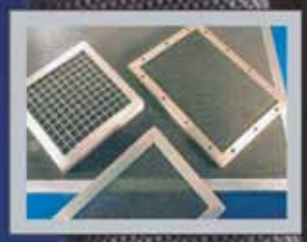
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Korrekturfaktoren von Nahfeldsonden und ihr Einsatz in der EMV

DIPL. ING. CARSTEN STANGE
Elektronische Entwicklungsingenieur, Langer EMV-Technik GmbH
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1. EINLEITUNG

DIE FIRMA LANGER EMV-TECHNIK ist seit 20 Jahren Dienstleister bei der Entstörung von Baugruppen. Durch die Lösung verschiedenster praktischer Probleme erarbeiteten wir uns einen großen Erfahrungsschatz bei der Messung von Hochfrequenzfeldern. Aus diesem Pool von Technologien entstanden eine Vielzahl an Nahfeldsonden, die bei der praktischen Arbeit an Baugruppen von großem Nutzen sind.

In der EMV bieten Nahfeldsonden die Chance z.B. Quellen der Störausendung in kleinräumigen Anordnungen zu finden. So können zum Beispiel durch Nahfeldmessungen an Schaltwandlern die Frequenzen der höchsten Störaussendung der gesamten Baugruppe bestimmt werden.

Allerdings sind die Messergebnisse nicht allgemein im physikalischen Zusammenhang nutzbar, da die Feldstärke auf die Sondenausgangsspannung abgebildet wird. Diese Spannung hängt zudem auch vom Frequenzgang der Sonde ab und ist damit frequenzabhängig. Durch diese Grenzen der Messtechnik können praktische Probleme nur durch Vergleichsmessungen gelöst werden.

Bei Entwicklungen schafft allerdings das Wissen der genauen Feldstärke und Verteilung der Störfelder Möglichkeiten, EMV Probleme frühzeitig zu beseitigen. Außerdem kann durch eine Absolutwertmessung die Vergleichsmessungen meist eingespart werden. Weiterhin liegt der Fokus des Entwicklers automatisch mehr auf den physikalischen Wirkmechanismen was zu einer schnelleren Behebung von Problemen führt.

2. ERZEUGUNG DER MAGNETFELDKORREKTUR

Der physikalische Wirkzusammenhang, auf dem die Nahfeldsonden beruhen ist das Induktionsgesetz. Es besagt, dass ein sich wechselndes Magnetfeld, welches durch eine Leiterschleife tritt, eine Spannung in dieser Schleife aufbaut. Der allgemeine mathematische Ausdruck dafür ist:

$$1)\quad \oint_{dA} E ds = -N \iint_{A} \frac{\partial B}{\partial t} dA$$

Im technischen Zusammenhang können hier Vereinfachungen eingeführt werden.

So lässt sich der linke Teil der Gleichung vereinfacht

durch die Spannung in einer Leiterschleife U_induziert ersetzen. Außerdem kann das Flächenintegral auf der rechten Seite einfach durch die Fläche A der Wicklung ersetzt werden.

Die induzierte Spannung in der Leiterschleife ist nun ein Maß für zeitliche Änderung der magnetischen Flussdichte.

2) $U_{induktion} = -N \frac{\partial B}{\partial t} A$

B magn. Flussdichte
t Zeit
A Fläche der Spule
N Anzahl der Windungen

Allerdings ist mit diesen Vereinfachungen keine Aussage über die Feldverteilung in der Wicklung möglich. Die magnetische Flussdichte wird über die gesamte Spulenfläche gemittelt.

Durch die Überführung der Betrachtung in den Frequenzbereich erhält man eine lineare Funktion, die direkt zwischen der Magnetfeldstärke und der induzierten Spannung vermittelt.

3) $U_{indiziert} = \omega BAN = \mu \omega HAN$
mit $B = \mu \cdot H$ in Luft

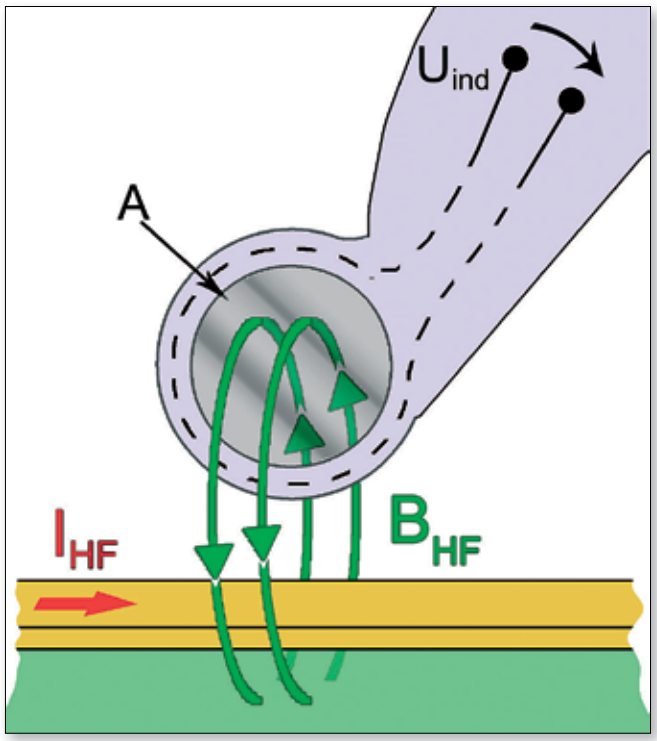


ABBILDUNG 1: Sondenaufbau schematisch.

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Die Messungen in der Hochfrequenztechnik werden meist im 50Ohm System durchgeführt. Durch diese niedrige Lastimpedanz weicht die Sondenausgangsspannung von der induzierten Spannung ab. Die Abweichung wird durch die Übertragungsfunktion der Sonde beschrieben. Allgemein gilt

4) $U_{out} = G_{Sonde} \cdot U_{induziert}$

Die Übertragungsfunktion ist Sonden spezifisch und muss messtechnisch ermittelt werden.

Der Magnetfeldkorrekturfaktor vermittelt nach Definition zwischen der Sondenausgangsspannung und dem verursachenden Magnetfeld.

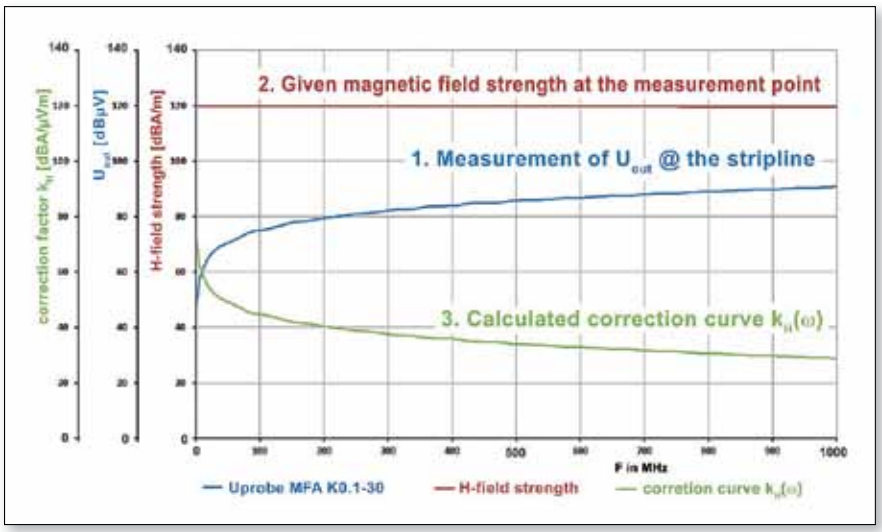


ABBILDUNG 2: Grafische Ermittlung der Korrekturkurve.

5) $\frac{H}{U_{out}} = k_H(\omega) = G_{Sonde} \frac{1}{\mu A N \omega} \left[\frac{A}{Vm}\right]$

3. BESTIMMUNG DER KORREKTURKURVE ANHAND DER MFA K0,1-30

Die neue Sonde MFA K0.1-30 soll in diesem Fall als Beispiel herangezogen werden. Sie wurde zum Messen von Magnetfeldern und Strömen an sehr kleinen Strukturen



entwickelt und kann dennoch mit Hand geführt werden. Der Messkopf ist speziell gestaltet um Umgebungsfelder stark zu unterdrücken. Somit können Messungen an Busleitungen mit 0,2mm Abstand bis zu einer Frequenz von 1GHz durchgeführt werden.

Als Ausgangspunkt für die Ermittlung der Korrekturkurve dient eine Messung der Sonde an einer Hochfrequenz- Streifenleitung. An dieser kann ein über die Frequenz konstantes Magnetfeld generiert werden. Über dieses Feld wird die Übertragungscharakteristik der Sonde G_(SL-Sonde)=U_out/U_quelle bestimmt.

Aus der Übertragungscharakteristik wird nach einem speziellen mathematischen Verfahren die Übertragungsfunktion der Sonde berechnet. Danach wird die Magnetfeldkorrekturkurve kH (ω) mit Hilfe der Gleichung (5) und der Sondenparameter bestimmt.

Das folgende Bild (2) beschreibt die Erstellung der Korrekturkurve grafisch.

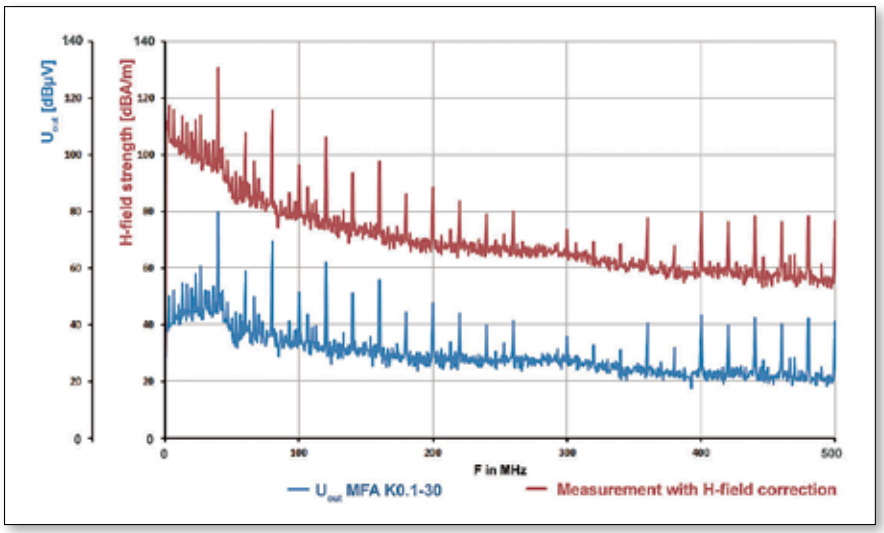


ABBILDUNG 3: Mess- und korrigierter Wert einer Messung am Versorgungspin eines Schaltkreises.

Es sind noch weitere Korrekturfaktoren, wie zum Beispiel der in der gemessenen Leitung fließende Strom, denkbar. Allerdings sind diese Faktoren nur unter Vorgabe der Messanordnung gültig.

4. BEISPIELHAFTE MESSUNG DER MAGNETFELDSTÄRKE

Die Messung der magnetischen Feldstärke in einem bestimmten Bereich der Baugruppe bzw. einer signalführenden Leitung erfolgt ähnlich der Bestimmung des Korrekturfaktors.

Man führt die Sonde an den jeweiligen Messort und misst die Sondenausgangsspannung. Danach wird die Spannung mit Hilfe des Korrekturfaktors in Wert und Einheit verändert. Das Ergebnis dieser Korrektur ist der Messwert der magnetischen Feldstärke.

Die folgende zugeschnittene Größengleichung wird für die Korrektur der Messwerte verwendet. Diese wird durch Umstellen und logarithmieren der Gleichung (5) erhalten.

$$6)\quad H\left[dB\frac{A}{m}\right] = U_{out}\left[dB\mu V\right] + k_H\left[dB\,\frac{A}{\mu Vm}\right]$$

In Abbildung 3 wird der Frequenzgang (blau) an einem Versorgungspin eines Schaltkreises dargestellt. Zu erkennen sind die periodisch widerkehrenden Maxima der Taktfrequenz, mit dem der Schaltkreis betrieben wird. Der Frequenzgang (rot) zeigt hingegen den mit der Korrekturkurve verrechneten Frequenzgang. Bei diesem können die Werte der durch den in der Versorgungsschleife fließenden HF- Strom hervorgerufenen Magnetfeldstärke abgelesen werden.

Aus den Feldstärkewerten sind zum Beispiel Spannungseinkopplungen in andere auf der Baugruppe befindlichen Schleifen einfach mit Gleichung (3) berechenbar.



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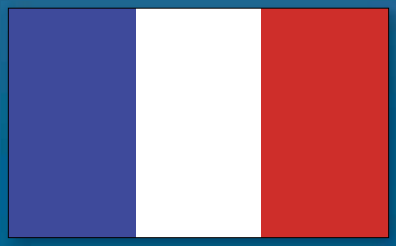
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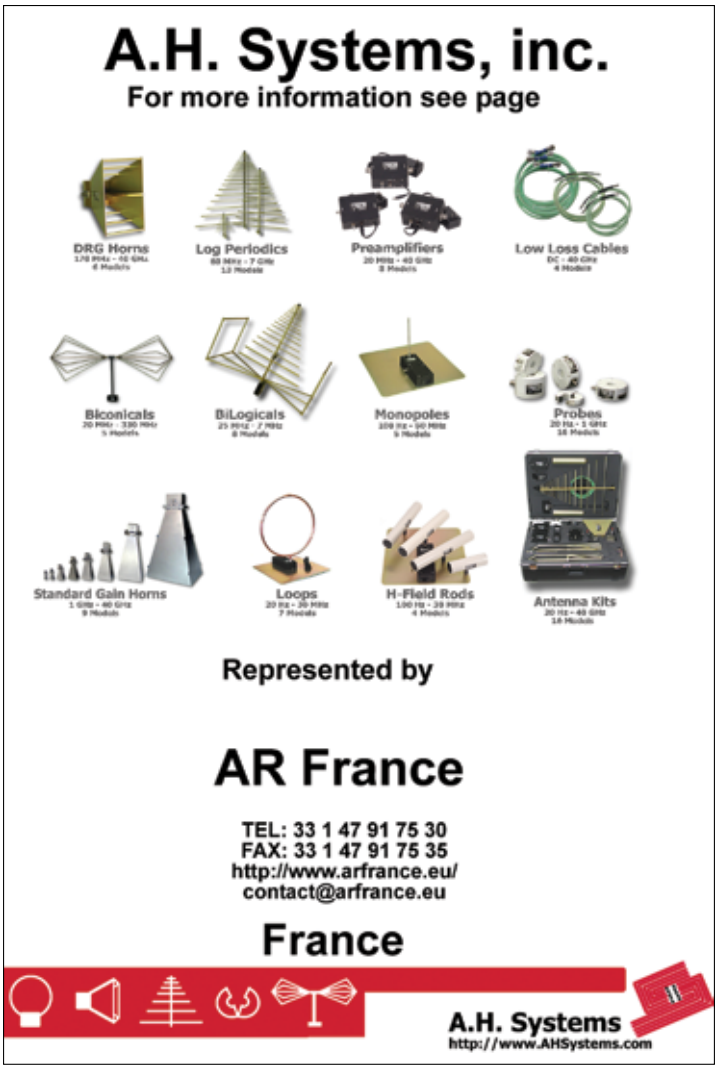
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PRÉSENTATION D'ÉTUDE SUR CAS INDUSTRIELS

Résumé *- Le but de cet article est de présenter la mesure en champ proche utilisée dans le cadre de l'investigation des problèmes liés à la CEM. Plusieurs études industrielles sont présentées pour illustrer les avantages de cette méthode appliquée à une démarche d'investigation.*

Mots-clés *- CEM, outil d'investigation, champ proche, émission rayonnée, carte électronique*

I. CONTEXTE

DANS LES PHASES DE CONCEPTION électronique, la CEM est en grande partie responsable de dépassement de coût et de décalage de planning. Actuellement, les experts CEM ne disposent pas ou peu d'outils spécifiques pour améliorer la conception avant les phases de validation finale. Les retours d'expériences restent souvent les meilleures données d'entrée dans cette situation. Pour essayer de répondre à cette problématique, nous avons débuté, il y a six ans, le développement et l'amélioration d'un banc de test basé sur la technique de mesure en champ proche.

II. INTRODUCTION

La méthode couramment utilisée pour mesurer les émissions rayonnées utilise une antenne pour capter le «champ lointain» émis par le dispositif sous test. Tous les tests de qualification standards sont basés sur ce principe. Le champ électromagnétique (EM) dans la région lointaine pourrait se résumer à une onde plane se propageant dans l'espace libre dont l'impédance d'onde est égale à 377 ohms. Toute information sur la source est perdue et seule l'amplitude du champ (de l'onde) est sauvegardée. Cette

approche fournit des informations pertinentes pour aider à qualifier la conformité CEM. Mais cette information ne permet pas d'identifier l'origine de la source ou de caractériser la perturbation.

La technique de mesure en champ proche est très peu affectée par les perturbations extérieures. Le setup de mesure est plus simple que celle de la mesure en champ lointain. La mesure est réalisée en espace libre. Il n'est pas nécessaire d'utiliser de chambre anéchoïque. Le coût de mesure est ainsi réduit. La reproductibilité de la mesure est excellente. Tout ceci fait de la mesure en champ proche un outil d'investigation très performant. Dans la partie suivante, plusieurs études sur des cas industriels sont présentées.

III. TECHNIQUE DE MESURE EN CHAMP PROCHE - ÉTUDE DE CAS INDUSTRIELS

Un grand d'articles présente cette technique de mesure [1][2][3]. A titre de rappel, la mesure de l'amplitude du champ proche est réalisé par un analyseur de spectre (SA) relié à la sonde de mesure, cf Fig. 1. Un amplificateur à faible bruit (LNA) peut être utilisé pour augmenter le rapport signal sur bruit (SNR).

Dans la partie suivante de cet article, nous allons illustrer la valeur ajoutée de la technique de mesure en champ proche sur certains cas d'étude industriel.

A. Cas 1 : *Investigation sur un problème d'émission rayonnée sur une carte électronique*

L'étude présentée ci-dessous, reprend une investigation effectuée par Nexio sur un produit de la société Eaton. Initialement, le client a mené une investigation basée sur la mesure GTEM. Un problème de conception a été relevé sur la carte « capteur » (carte sur la gauche de l'image de la Fig. 2).

Par la suite, une investigation en champ proche a été réalisée. Le résultat de cette étude est présenté par la Fig. 2. Une brève synthèse de cette étude est reprise ci-dessous:

a) Aucune émission rayonnée n'a été relevée sur la carte « capteur ».
b) Plusieurs pics d'émission ont été observées au-dessus des composants numériques.
c) L'activité numérique est également visible au-dessus du régulateur DCDC.
d) Une mauvaise connexion de terre du régulateur DCDC a été identifiée.
e) Les deux cartes sont reliées par un câble blindé à la terre.
f) Le plan de masse n'est pas connecté à la terre.

Le point «a» conclut que la carte du capteur n'est pas la réelle source des perturbations. Les points «c», «b» et «d» montrent que le réseau de découplage des composants numériques n'est pas optimal et génère une activité à haut fréquence sur le réseau d'alimentation (ground bounds). Les points 'e' et 'f' montre le chemin de propagation (effet d'antenne) de la perturbation numérique visible sur les tests GTEM.

Cet exemple nous montre que l'analyse générale effectuée par les tests CEM standard ne permet pas toujours d'identifier les réels problèmes de conception des cartes

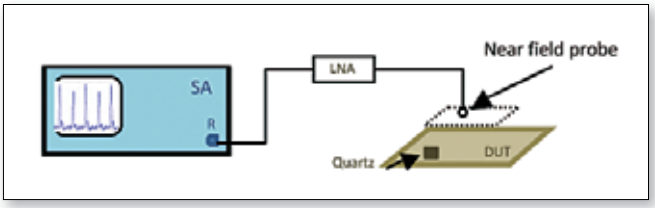


FIGURE 1: Magnitude near field measurement set-up

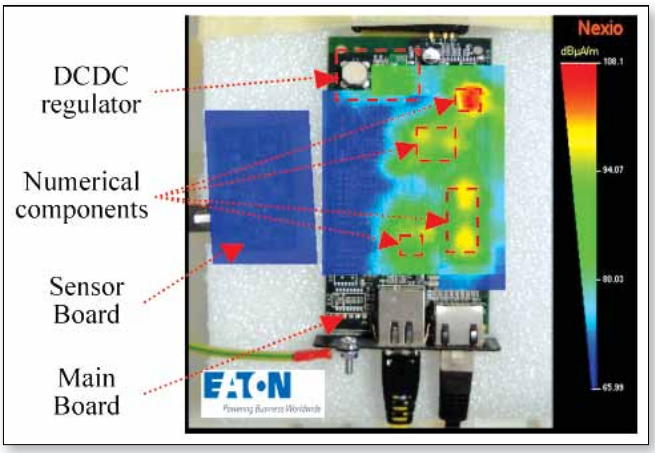


FIGURE 2: Magnitude near field measurement example (first run)

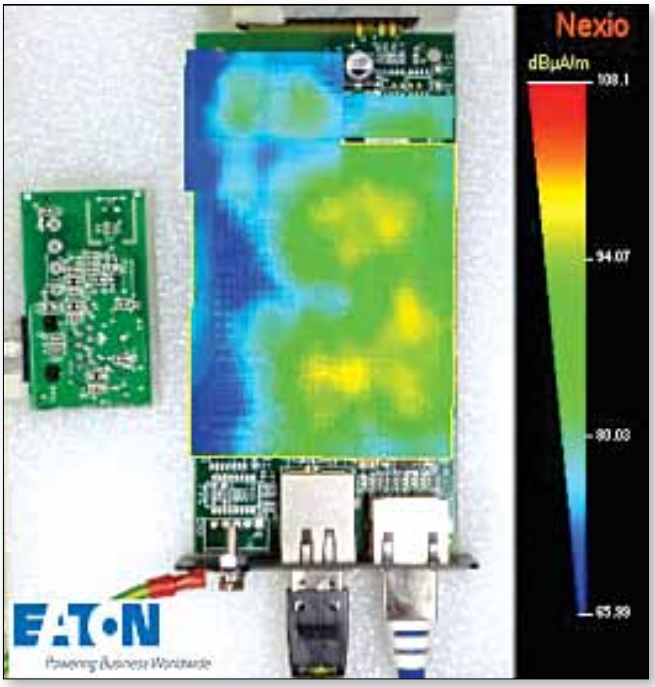


FIGURE 3: Magnitude near field measurement example (second run)

électroniques. Sans outil d'investigation, il est très difficile de localiser la réelle source de perturbation CEM et souvent ce sont les conséquences de la perturbation (ici effet d'antenne) qui sont localisées.

Fig. 3 montre une seconde analyse réalisée neuf mois après la précédente. Entre les deux mesures, des corrections ont été apportées au produit. Cette seconde analyse montre une réduction des niveaux d'émission des sources numériques (-1,5 dB) et du convertisseur DC/DC (-5 dB).

Pour conclure, cette étude montre qu'une investigation (en 2x1 journées) basée sur la mesure en champ proche permet d'identifier rapidement est précisément les sources

d'émission responsable des non-conformités CEM. On notera ici la très bonne reproductibilité de la mesure en champ proche. En comparant les deux mesures, nous constatons un écart de seulement 0,3 dB sur les parties non modifiée du design.

B. Cas 2 : *Defaut de production du boitier d'un ordinateur militaire durci*

L'étude présentée ci-dessous, reprend une investigation effectuée par Barco sur l'un de ses ordinateurs militaires durci. Les normes militaires en matière d'émission rayonnée sont très drastiques, en comparaison avec les normes EN. Une attention particulière a été portée durant la conception afin de minimiser le niveau d'émission, en particulier dans la bande de fréquence 30-88 MHz (bande radio). Pour éviter cela, les appareils électroniques installés dans le véhicule / bateau / avion, à proximité de l'antenne, doivent être conçus avec un très faible niveau d'émissions rayonnées. La conception et la qualification ont été faites par Barco et étaient conformes aux spécifications.

Ensuite la mise en production a été transférée vers l'Asie et les tests de non-régression ont été réalisés. La phase la plus critique est souvent la mesure des émissions rayonnées en chambre anéchoïque. Durant ces essais, Barco a rencontré quelques problèmes entre 30MHz et 1GHz, incluant la bande radio.

Une investigation en champ proche a été effectuée sur les moyens de mesure en champ proche Nexio. Les résultats sont présentés ci-dessous:

La mesure en champ proche a permis ici d'identifier rapidement et précisément les défauts de fabrication du boitier par la mise en évidence de fuites d'émission rayonnée comme le montre les résultats de la Fig 5. En seulement une journée d'essai, cette étude a été bien moins couteuse qu'une étude en chambre anéchoïque.

Après avoir localisé la zone de faible efficacité de blindage du boitier, une deuxième analyse a été effectuée le jour même. L'équipement a été ouvert et une mesure en champ proche a été réalisée sur chacune des cartes électroniques.

En association la localisation des faiblesses d'efficacité de blindage du boitier avec l'identification des sources internes d'émission, il est relativement facile de réduire significativement les niveaux d'émission rayonnée du produit.

La localisation des zones de faible efficacité de blindage permet de spécifier un nouveau boitier ou de corriger l'ancien. Toutefois cette opération peut être longue et couteuse. L'identification des sources de perturbation permet de travailler au niveau des cartes électroniques. La correction peut être rapide avec un coût réduit (optimisation de la valeur de condensateur de découplage, des filtres, logiciel embarqué ... ou comme dernière solution un blindage local interne).

C. Cas 3 : *Problème de conception CEM rayonnée sur un ordinateur militaire durci*

L'étude présentée ci-dessous reprend une investigation effectuée par Barco sur l'un de ses ordinateurs militaire durci. La conception et la qualification ont été réalisées par Barco. Une non-conformité a été relevée pour une configuration de test spécifique lors des essais de qualification standard. L'identification des sources a été très difficile par les moyens d'essais standards.

Pour identifier les points faibles de la conception CEM

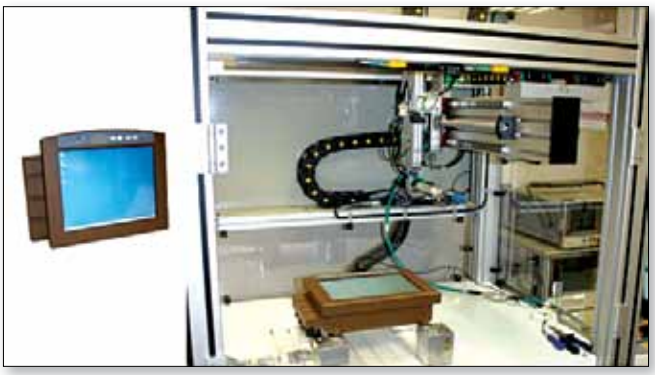


FIGURE 4: Near field scan Barco computer (equipment and scanner)

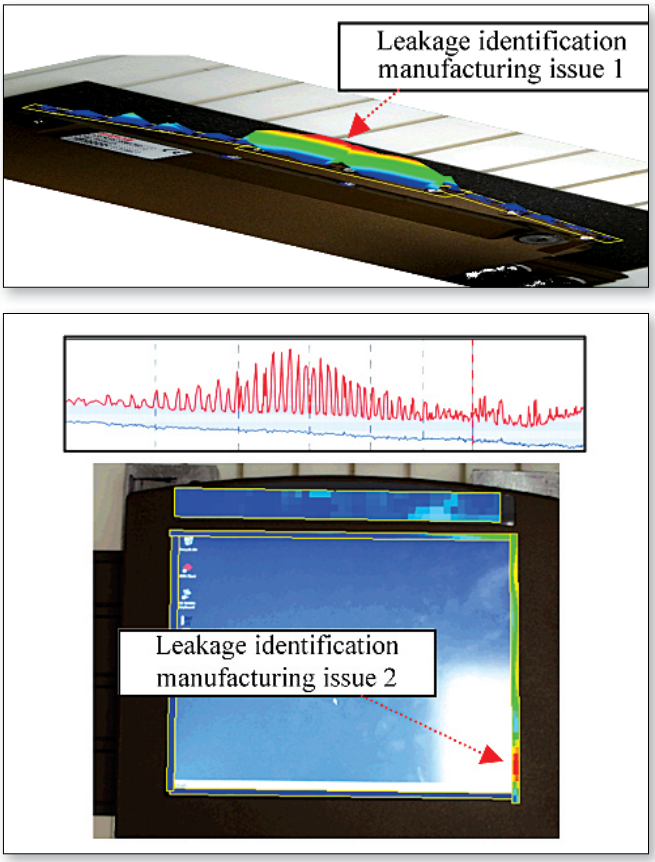


FIGURE 5: Barco rugged computer manufacturing issue



FIGURE 6: Internal sources localization

une investigation en champ proche a été réalisée sur les moyens d'essais de Nexio:

La mesure en champ proche a permis ici d'identifier rapidement et efficacement le problème de conception (couplage interne transmis par des câbles externes). L'identification des sources d'émission internes a permis de mettre en place des solutions pour réduire le couplage (blindage, filtrage et logiciel). Cette étude réalisée en moins d'une journée a été bien moins couteuse qu'une étude en chambre anéchoïque. Cette dernière n'aurait peut-être pas aboutie à l'identification des sources réelles. La solution aurait surement été de blinder le câble (cout/poids plus important et contrainte supplémentaire pour le client).

IV. CONCLUSION

Nous avons décrit dans cet article trois d'études, basées sur l'utilisation du moyen de mesure en champ proche, menées sur des cas industriels. L'objectif était de mettre en évidence la pertinence de la mesure en champ proche dans l'identification des sources de non-conformité. Sans être infaillible, cette méthode permet d'offrir un outil d'investigation puissant pour optimiser la conception des cartes électroniques et d'investiguer rapidement les non-conformités CEM. Les principaux avantages de la mesure en champ proche sont les suivants:

- Faible coût (chambre anéchoïque non nécessaire)
- Non dépendant du setup (seul le produit est mesuré)
- Méthode non-invasive (Mesure sans contact)
- Haute reproductibilité de la mesure (<0,5 dB)
- Identification des causes réelles de perturbation
- Très large bande: 10kHz-5 GHz (et peut être étendue)

Un avantage supplémentaire de la méthode de mesure en champ proche est la rapidité d'investigation pour l'identification des sources réelles de perturbation. Un temps précieux est gagné et la conception est sécurisée pour potentiellement être réutilisée pour les versions de produit futures.

REMERCIEMENT

Je voudrais profiter de ces quelques lignes pour remercier particulièrement les sociétés Eaton et BARCO pour avoir accepté de partager les résultats des études d'investigation réalisées sur leurs produits.

RÉFÉRENCES

- [1] Jin Shi, Michael A.Cracraft, Jianmin Zhang, Richard DoBroff,"Using near-field scanning to predict radiated fields", IEEE, EMC 2004 International Symposium, 14 - 18 vol.1, 9-13 Aug. 2004
- [2] Adam Tankielun, Uwe Keller, Etienne Sicard, Peter Kralicek, Bertrand Vrignon, "Electromagnetic Near-Field Scanning for Microelectronic Test Chip Investigation", IEEE EMC Society Newsletter, Collection IEEE EMC, Octobre 2006
- [3] D. Baudry, A. Louis, B. Mazari, "Overview of emission and susceptibility investigation and modeling with near-field measurements.", URSI GA 2008, Chicago, USA, August 2008
- [4] S.Serpaud, L.Arnal, B.Ravelo, D.Baudry, "Conception Assistée par Mesure en Champ Proche", Workshop 2EMC 2010, Rouen
- [5] "Technical Improvement of the Near Field Measurement: The Vector Near Field Scanning", Sébastien Serpaud, Samuel Leman; EMCEurope2013, Septembre 2013, Brugge, Belgium.
- [6] Free NFSVIEWER software :
- http://www.nexiogroup.com/index.php/produits-fr/bat-scan-fr/2-non-categorise/140-nfs-viewer-fr



FIGURE 7: Near field scan Barco computer (equipment and internal details)

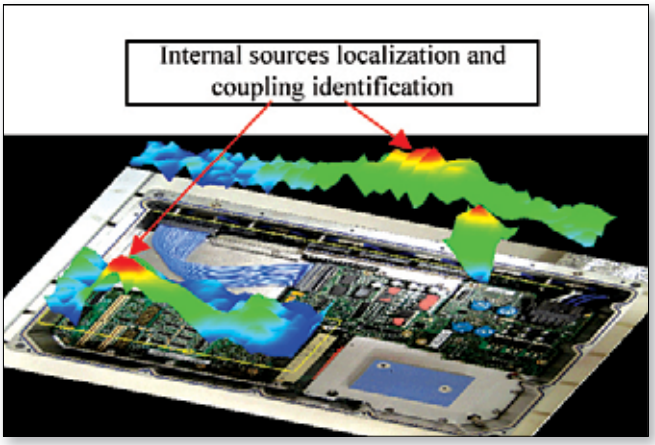


FIGURE 8: Barco rugged computer EMC design issue

	Without NFS tools	With NFS tools
Investigation time		
Investigation cost		
Impact of issue (design modification result)	• Shielding box conception • Review of customer specification	• Component changing (reference or value) and/or review of PCB design
Risk of issue in the next design review	High	Low

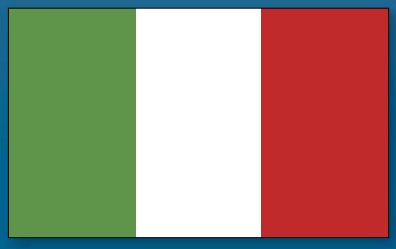
FIGURE 9: Benefits of investigation tool

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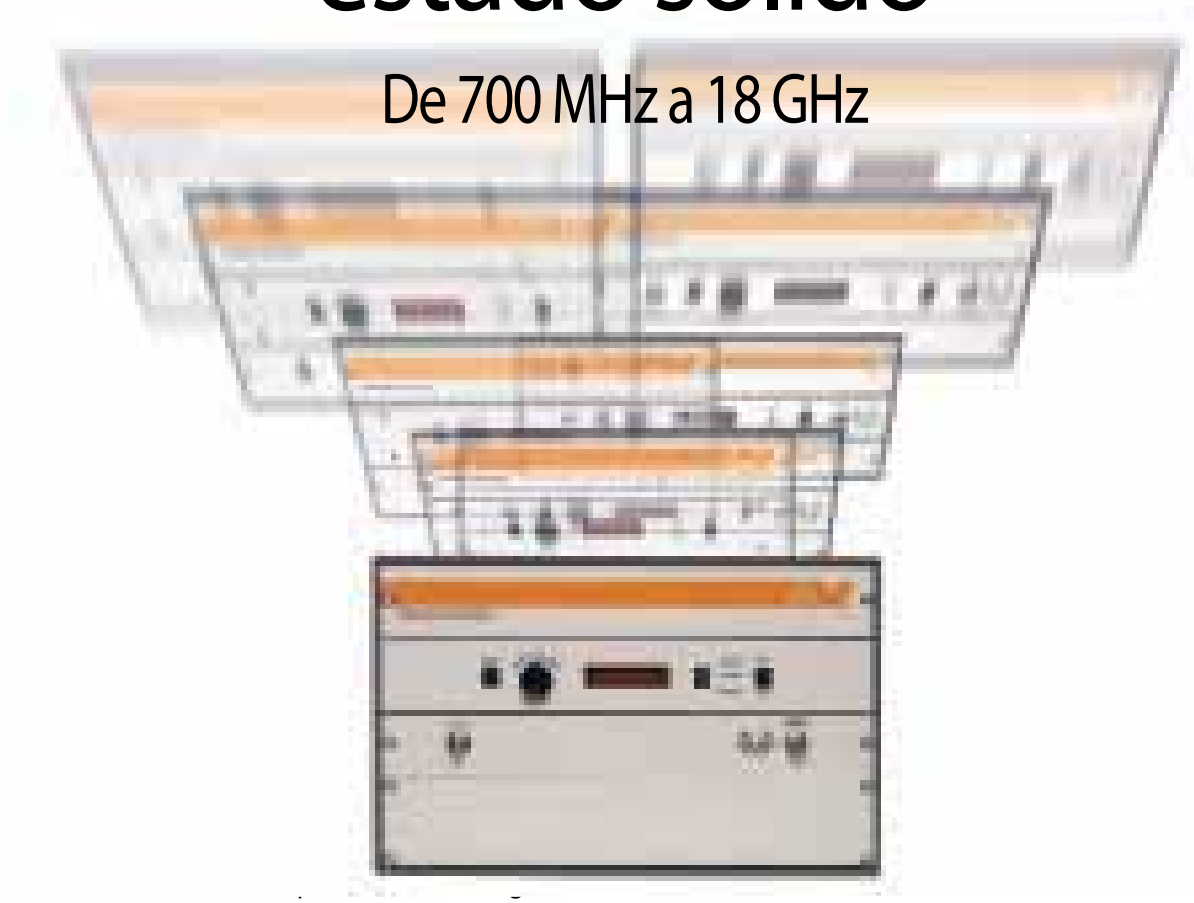
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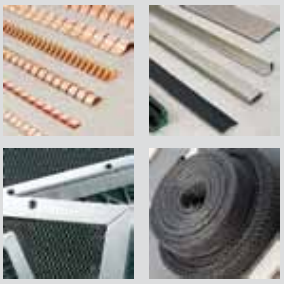
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Artículo sobre Tecnología de IEM – Revista Interference Technology

TIM FORNES
Dr., Científico Principal de Investigación Química, LORD Corporation
Barcelona, España

PREVENCIÓN DE LA INTERFERENCIA ELECTROMAGNÉTICA EN LOS DISPOSITIVOS ELECTRÓNICOS

LA INTERFERENCIA ELECTROMAGNÉTICA (IEM) es una interrupción no deseada de la comunicación de un dispositivo eléctrico causada por las ondas electromagnéticas exteriores. Tales ondas o radiaciones exteriores inducen corrientes eléctricas que interfieren con el funcionamiento normal del dispositivo. En pocas palabras, la IEM es el resultado de la interferencia entre las señales exteriores y las deseadas.

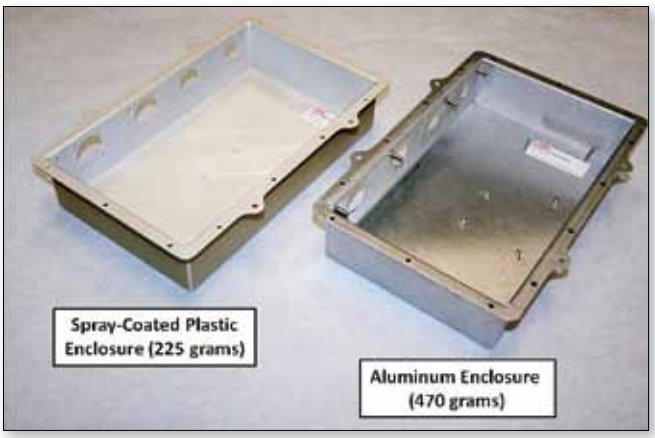
La IEM puede provocar interrupciones intermitentes del funcionamiento de un dispositivo. Si bien esta interrupción puede resultar benigna, como sucede en una distorsión durante una conversación por teléfono móvil, también puede implicar consecuencias graves si afecta a aplicaciones del sector del transporte, en las que, por ejemplo, una simple interrupción breve del sistema de aviónica de la aeronave puede resultar peligrosa.

Durante el diseño de los dispositivos electrónicos, los fabricantes deben cumplir con las normativas regionales y globales destinadas a prevenir la interferencia electromagnética. Dado que prácticamente cualquier dispositivo que incorpore algún componente electrónico es susceptible a la radiación exterior, los fabricantes han desarrollado diversos métodos de puesta a tierra de los circuitos y blindaje de los dispositivos.

MÉTODOS DE BLINDAJE FRENTE A LA IEM

Tradicionalmente, los fabricantes de dispositivos eléctricos han utilizado carcazas envolventes metálicas como protección frente a la IEM. Los cuerpos envolventes metálicos, fabricados en materiales tales como aluminio, acero, níquel y aleaciones de níquel-hierro, actúan como límite relativamente grueso y excepcionalmente conductor alrededor del dispositivo electrónico que refleja y absorbe las señales perjudiciales. Aunque los cuerpos envolventes metálicos minimizan satisfactoriamente la IEM, resultan más pesados de lo deseado para muchas aplicaciones electrónicas.

En su búsqueda de materiales de construcción más ligeros, muchos fabricantes están cambiando a los materia-



Los revestimientos epoxi altamente conductores permiten lograr niveles de blindaje similares al aluminio con tan solo una fracción del peso de los cuerpos envolventes tradicionales. Esta fotografía muestra el ahorro de peso logrado mediante la conversión de un cuerpo envolvente de aluminio (derecha) a un cuerpo envolvente termoplástico (izquierda), que ha sido pulverizado con el nuevo revestimiento epoxi.

les termoplásticos. La fabricación de carcazas envolventes termoplásticas resulta más fácil y rápida. Al utilizar metales, la forma de la carcaza envolvente se realiza por estampado, un proceso costoso y largo que no se adapta con sencillez a las formas más intrincadas. Sin embargo, los termoplásticos pueden ser fácilmente moldeados por inyección para producir formas complejas con un alto rendimiento. Esta combinación de diseño ligero y velocidad de producción se traduce en una fabricación de carcazas envolventes de plástico menos costosa en comparación con las de tipo metálico.

Por otro lado, los plásticos son intrínsecamente aislantes de la electricidad, por lo que ofrecen una insignificante protección frente a la IEM. Para superar este problema, los fabricantes recurren a menudo a la utilización de un proceso de metalización no electrolítica (quimioplastia) o al recubrimiento de los plásticos con revestimientos conductores de alta densidad de relleno. Esto transforma la pieza de plástico en un blindaje frente a la IEM.

La metalización no electrolítica es un proceso químico intensivo, de varias etapas, que en última instancia deposita sobre el plástico una capa delgada de metal puro. Si bien la metalización no electrolítica ofrece altos niveles de blindaje debido a su revestimiento metálico puro, el proceso es agresivo con el medio ambiente y requiere un elevado tiempo, además de precisar excesiva mano de obra y resultar costoso. En concreto, el proceso consiste, en primer lugar, en un hinchamiento de los plásticos mediante un disolvente y, seguidamente, en someterlos a un ataque químico con ácidos agresivos, tales como el ácido sulfúrico y los ácidos crómicos. Luego del ataque químico las piezas se enjuagan, se aplica un catalizador sobre su superficie y, por último, se procede a depositar el metal (tal como cobre o níquel) sobre la superficie a través de una reacción de reducción. Este proceso, que puede contar con etapas de clarificación/enjuague adicionales, ha sido objeto de estudio recientemente, dado que utiliza productos químicos peligrosos para el operador y el medio ambiente. Debido a la intensificación de las regulaciones ambientales, los diseñadores de blindajes están recurriendo a técnicas alternativas de revestimiento de los plásticos.

Además de los problemas relacionados con la seguridad y el medio ambiente, la metalización no electrolítica puede contar con una adherencia limitada, especialmente alrededor de los bordes o esquinas expuestas o cuando las tensiones sobre el sustrato puedan ser elevadas. En tales situaciones, existe el riesgo de que se desprenda el revestimiento metálico, lo que se traduce en orificios a través de los cuales pueden penetrar las ondas electromagnéticas. Este problema se agrava por la gran divergencia de propiedades (como por ejemplo módulo, alargamiento y coeficiente de expansión térmica) entre el sustrato de plástico y el revestimiento metálico.

Como alternativa a los cuerpos envolventes metálicos y a la metalización no electrolítica, muchos fabricantes utilizan revestimientos conductores de alta densidad que se pulverizan sobre el cuerpo envolvente termoplástico. Los revestimientos consisten en una resina termoplástica o termoendurecible, tales como polimetilmetacrilato y epoxi respectivamente, que se encuentra altamente cargada con

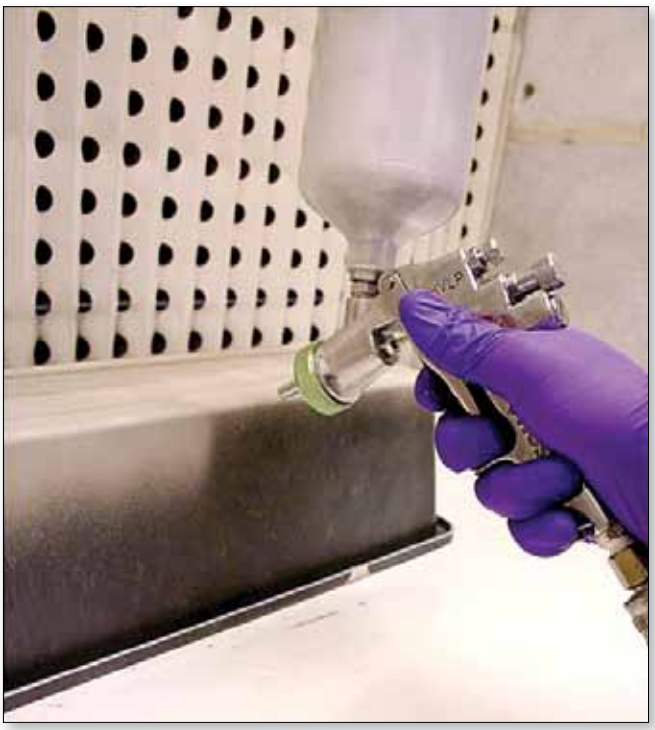


partículas metálicas, tales como plata, cobre, plata-cobre, níquel o combinaciones híbridas de los mismos. Aunque los revestimientos brindan una alta eficacia de blindaje, sus altas densidades pueden suponer una merma de propiedades tales como la adhesión, la flexibilidad o el peso, acompañada de un aumento de costo.

Otra posibilidad para la fabricación de termoplásticos a prueba de IEM consiste en rellenar el material termoplástico con partículas conductoras. Si bien esta estrategia elimina la necesidad de aplicar un revestimiento conductor tras el moldeo por inyección del plástico, el cuerpo envolvente resultante es todavía mucho menos conductor que el logrado mediante metalización no electrolítica o por medio de un revestimiento conductor de alta densidad.

REVESTIMIENTOS EPOXI DE ALTA CONDUCTIVIDAD

Los fabricantes de dispositivos electrónicos están buscando un revestimiento conductor para termoplásticos que ofrezca un blindaje equivalente a la metalización no electrolítica sin los problemas en términos de seguridad, medio ambiente y costo inherentes al proceso de metalización. Con la finalidad de satisfacer esta necesidad, están apareciendo en el mercado nuevos revestimientos epoxi altamente conductores. Adicionalmente, estos revestimientos resuelven la disyuntiva entre eficacia de blindaje y propiedades de rendimiento que normalmente se observa en los revestimientos de alta densidad tradicionales. Los nuevos revestimientos, basados en una novedosa combinación de resina epoxi, cargas conductoras y agentes de curado, son capaces de autoensamblarse formando una estructura única durante el curado. Esta estructura presenta inherentemente una elevada conductividad, si bien su naturaleza sigue siendo en gran medida polimérica. En última instancia, esto conduce a un revestimiento ligero, con muy elevados niveles de blindaje frente a la IEM. En concreto, los revestimientos autoensamblantes ofrecen un blindaje de +85 dB a 25 micrómetros (1 mil) de espesor sobre una amplia gama de frecuencias. Gracias a su naturaleza polimérica, los revestimientos también pueden lograr mayores niveles de adherencia y flexibilidad. Adicionalmente, son resistentes a los ambientes de alta temperatura, humedad y salinidad a los que las aplicaciones electrónicas a menudo se ven expuestas.



Aplicación por spray de capas de revestimiento epoxi altamente conductor sobre un sustrato de plástico.



Versión flexible del adhesivo altamente conductor curado en un disco vde 1 mm de espesor.

Estas eficientes prestaciones resultan especialmente significativas para los fabricantes que deseen cambiar de un peligroso proceso de metalización no electrolítica a un revestimiento que ofrece un blindaje de al menos 85 dB o más con aproximadamente el mismo espesor. Por otra parte, los revestimientos tradicionales, a la misma densidad y grosor que los revestimientos autoensamblantes anteriormente citados, no brindarán un blindaje frente a la IEM superior a 85 dB. Teniendo esto presente, los fabricantes se muestran reticentes a aplicar revestimientos de mayor espesor debido a las restricciones en términos de costo y/o peso.

La característica química base de los revestimientos permite adaptar el material a varias formas de productos útiles, tales como revestimientos, adhesivos y películas. Como revestimiento por pulverización, se puede aplicar fácilmente de forma manual o mediante un equipo automatizado. La aplicación por spray se maneja del mismo modo que una pintura y puede ser aplicada sobre termoplásticos con formas muy complejas con ayuda de una pistola de pulverización de alto volumen y baja presión (HVLP). Para lograr un control preciso del espesor en una pieza, los revestimientos se pueden aplicar mediante sistemas robóticos. Por otra parte, posee una vida útil indefinida a temperatura ambiente.

La estabilidad a temperatura ambiente o la naturaleza latente del revestimiento permite manipular la base química en forma de un adhesivo aplicable en estado líquido, lo que facilita su utilización como un adhesivo tradicional, pero

con propiedades de blindaje frente a la IEM.

En su forma de película, el material base puede ser laminado en grandes piezas de recubrimiento para aplicaciones de grandes dimensiones. Esta forma resulta particularmente útil en la industria aeroespacial, en la que se puede aplicar sobre grandes zonas de una aeronave durante su montaje, ofreciendo así protección tanto frente a la IEM como contra la caída de rayos. Por último, en función de las exigencias mecánicas, el material base, ya sea en forma de spray, adhesivo o película, puede ser formulado para aplicaciones rígidas o flexibles.

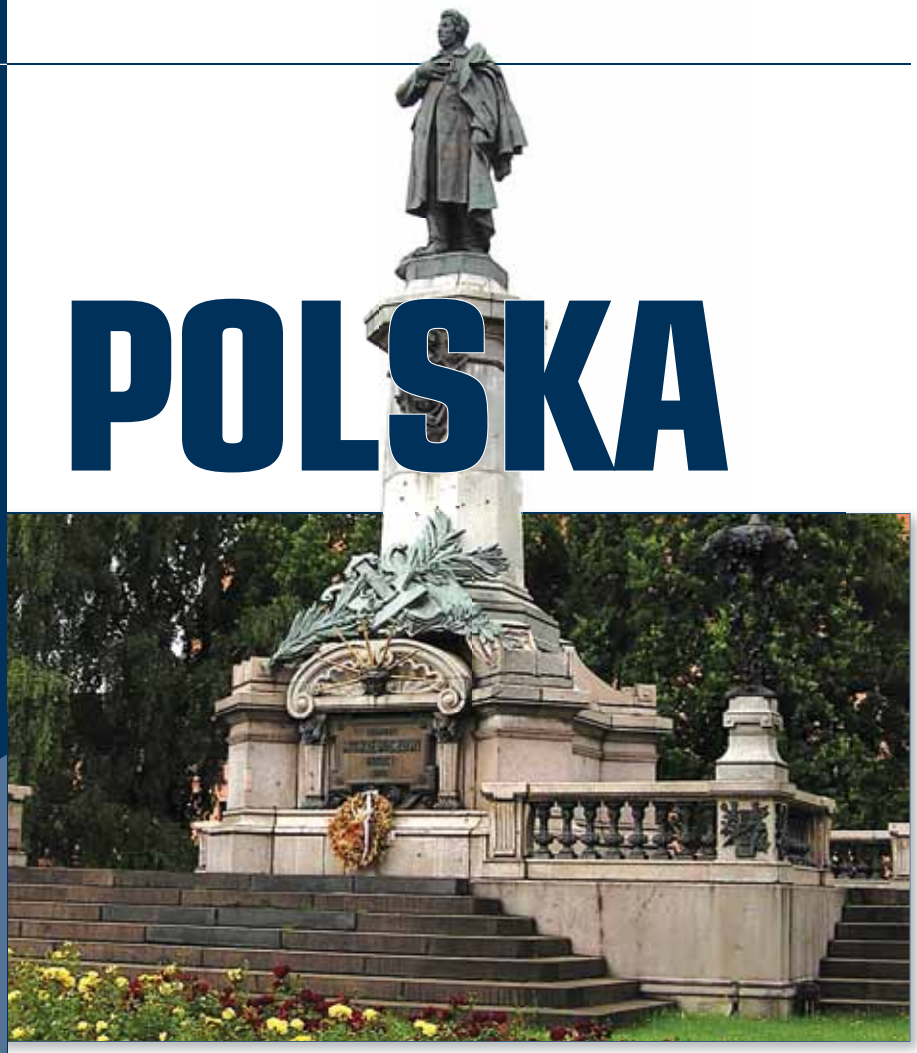
En los procedimientos de reparación, los revestimientos epoxi altamente conductores están disponibles en forma de spray presurizado. Este sencillo método de aplicación permite administrar directamente el revestimiento in situ, sin necesidad de pistolas de pulverización, sistemas de aire comprimido o mangueras. Por ejemplo, si un cuerpo envolvente o una pieza sufre desgaste o desperfectos durante su uso, es posible restaurar la sección dañada mediante una simple pulverización. Si una sección externa de una aeronave sufre daños que causen la eliminación parcial de la capa de epoxi, el técnico de reparación puede pulverizar el revestimiento sobre la sección dañada o reparada.

Gracias a los revestimientos epoxi de alta conductividad, los fabricantes tienen a su alcance un material que es predominantemente un polímero que se comporta de manera similar a un metal, sobre una gama muy amplia de frecuencias. Las aplicaciones en los diferentes sectores industriales han demostrado que, en general, estos revestimientos redundan en un ahorro de costos superior al 50 % con respecto a la metalización no electrolítica de los plásticos y otros sistemas acrílicos de altas prestaciones y alta densidad de relleno. En vistas de la tendencia de los fabricantes a incorporar cada vez más a sus diseños materiales de menor peso, los revestimientos de alta conductividad pueden aportar una solución de blindaje frente a la IEM eficiente y económica que cumpla con las expectativas de la industria.

El Dr. Tim Fornes *trabaja como Científico Principal del Departamento de Investigación Química de LORD Corporation y es el responsable del diseño, creación, caracterización y modelización de novedosos adhesivos y revestimientos con base polimérica, que tienen importancia comercial en los sectores de la electrónica, aeroespacial y automoción. Fornes es autor o coautor de 19 publicaciones técnicas revisadas por expertos y es coinventor de seis patentes (dos publicadas, cuatro pendientes de tramitación). Es graduado en Ingeniería Química por la Universidad Estatal de Carolina del Norte (licenciatura) y por la Universidad de Texas en Austin (máster y doctorado).*



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| ΔN SASAC | > 4dB, i co dalej?

JAN SROKA, Professor, Warsaw University of Technology



Strata czasu to strata pieniędzy

Test odporności promieniowanej skróć z dni do godzin...

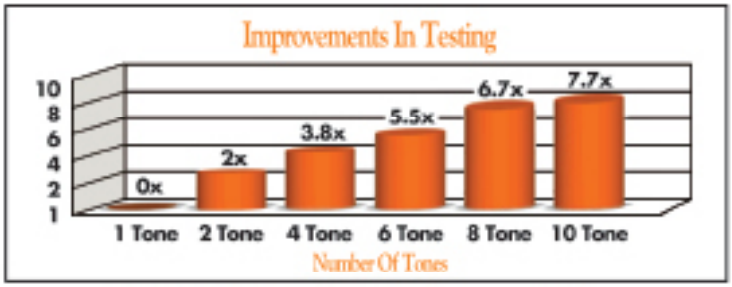


Używając nasz NOWY Tester MultiStar Multi-Tone

Dokładność testów EMC jest najważniejsza, zazwyczaj jednak (nie rozpisując się zbyt długo) test jest kosztowny i czasochłonny, co wydłuża drogę produktu na rynek. Z prędkością rewolucyjnego testera MultiStar Multi-Tone, nie musisz już dłużej ślęczeć na nudnymi testami EMC odporności promieniowanej.

Koncentrując swoją uwagę w czasie odpowiedzi układu na testowaniu wielu częstotliwości symultanicznie zwiększasz prędkość testu, skracasz czas przygotowania produktu na rynek i eliminujesz kosztowne badania w komorze.

Naśladując realny świat wykorzystaj narażenie EUT na więcej niż jedna częstotliwość w tym samym czasie. MultiStar Multi-Tone Tester spełnia wymagania normy IEC 61000-4-3 i wszystkie pokrewne.



IEC 61000-4-3 1% step sizes, taking into account dwell time

Jeśli wierzysz, że strata czasu to strata pieniędzy, nie zastanawiaj się. Zainteresuj się naszym nowym testerem MultiStar Multi-Tone.

Nie zapomnij także o naszym nowym cyfrowym (bazującym na DSP) odbiorniku EMI. Zadziwiająca prędkość. Niewiarygodna dokładność.

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| ΔN SASAC | > 4dB, i co dalej?

JAN SROKA
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STRESZCZENIE. Pojęcie tłumienia środowiska jest rozszerzeniem na zjawiska polowe pojęcia tłumienia używanego w teorii obwodów. Zależy ono od anten użytych do jego pomiaru i dlatego nie może być wykorzystywane jako obiektywny wskaźnik przydatności komór częściowo bezodbiciowych oraz poligonów pomiarowych do badań emisji promieniowanej. Za taką wielkość uznano tłumienie środowiska uzyskane z użyciem anten izotropowych. Pomiarów takich nie da się przeprowadzić, natomiast tłumienie pomierzone innym zestawem anten da się przeliczyć na wartości tłumienia jakie uzyskałoby się z wykorzystaniem anten izotropowych. To tłumienie po przeskalowaniu nazwano znormalizowanym normalized site attenuation NSA. Kryterium przydatności komór do pomiarów jest odchyłka NSA od wartości teoretycznej o mniej niż ±4*dB*. Komór w których $|\Delta N\ SA_{SAC}| > 4dB$ można używać do pomiarów jeśli pomierzy się dla nich współczynnik komory chamber factor CF oraz współczynnik szarości gray factor GF. Pierwszego ze współczynników można użyć jako poprawki, drugiego jako błędu granicznego w bilansie niepewnos´ ci pomiaru.

Słowa kluczowe: znormalizowane tłumienie środowiska, antena izotropowa, komora częściowo bezodbiciowa, współczynnik komory, współczynnik szarości.

WSTĘP

Za środowisko odniesienia w weryfikacji komór częściowo bezodbiciowych *semi anechoic chamber SAC* oraz poligonów pomiarowych *open area test site OATS* do badań emisji promieniowanej pola elektrycznego w przedziale częstotliwos´ ci od 30*MHz* do 1*GHz* przyjęto wyidealizowany poligon pomiarowy, którym jest półnieskończona próżnia z doskonale przewodzącą płaszczyzną, a za wielkość odniesienia przyję to znormalizowane tłumienie stanowiska pomiarowego *normalized site attenuation NSA*. Jest to tłumienie jakie uzyskałoby się na drodze pomiarowej z wykorzystaniem anten izotropowych. Można wyprowadzić zależność między *NSA*, a tłumieniem pomierzonym innym zestawem anten. Pomiar *NSA* odnosi się do wartości teoreycznej. Dokument [2] dopuszcza do pomiaru emisji pro-



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mieniowanej komory, w których odchyłka *NSA* od wartości teoretycznej jest mniejsza od ±4*dB*.

Bywają komory, zwłaszcza starszego typu, w których *NSA* odbiega od teoretycznej wartości o więcej niż ±4*dB*. Wynika to z faktu, że w przeszłości nie było materiałów tłumiących skutecznie pole magnetyczne dla małych częstotliwości, począwszy od 30*MHz*. Komorę w której w przedziale częstotliwości od 30*MHz* do 200*MHz* *NSA* odbiega od teoretycznej wartości o nie więcej niż ±12*dB*, można stosować do pomiarów, po pomierzeniu dla niej współczynnika komory *C F chamber factor* oraz współczynnika szarości *GF gray factor*, o których jest mowa w [3] oraz [6].

Duża odchyłka *NSA* od wartości teoretycznej świadczy o tym, że warunki środowiska przestrzeni pomiarowej są dalekie od warunków przestrzeni otwartej, czyli od warunków strefy dalekiej pola. Wówczas antena pomiarowa (odbiorcza) znajduje się w strefie bliskiej pola wytworzonego przez *EUT*.

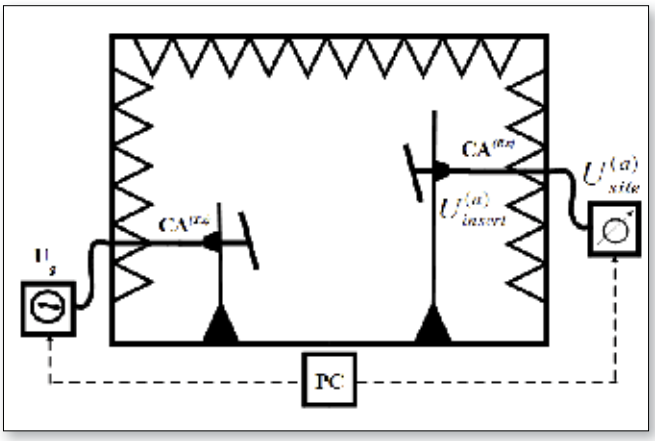
ZNORMALIZOWANE TŁUMIENIE STANOWISKA POMIAROWEGO *NSA*

Komorę częściowo bezodbiciową lub poligon pomiarowy z antenami do pomiaru NSA: nadawczą *Tx* oraz odbiorczą *Rx* można uznać za czwórnik, którego bramą wejściową jest przyłącze anteny nadawczej, a wyjściową przyłącze anteny odbiorczej. Jego tłumienie nazywa się tłumieniem środowiska pomiarowego SA.

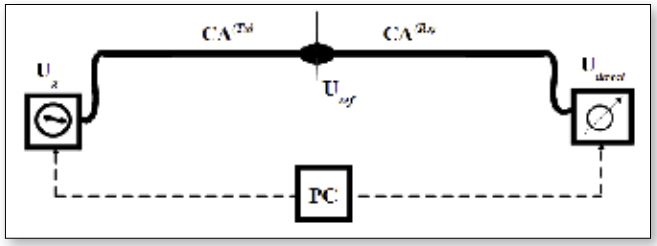
Do pomiaru SA trzeba użyć generatora sygnału sinusoidalnego, którego napięcie wyjściowe oznaczymy *Ug*, kabla anteny nadawczej z tłumiemniem $CA^{(Tx)}$, kabla anteny odbiorczej o tłumieniu $CA^{(Rx)}$ oraz miernika sygnału. Pomiaru tłumienia trzeba dokonać w dwu krokach. W pierwszym trzeba wyznaczyć napię cie odniesienia U_{ref} w miejscu przyłączenia anteny odbiorczej bez wtrąconego czwórnika, czyli kiedy kable poła¸czone są bezpośrednio, jak na Rys.1. Napięcie to można obliczyć ze wskazania miernika U_{direct}. W skali decybelowej wyraża się ono wzorem

1) $U_{ref} = U_{direct} + CA^{(Rx)}$

Następnie trzeba zamontować anteny i utrzymując ten sam sygnał *Ug* generatora co w kroku pierwszym, wyznaczyć napięcie $U^{(a)}_{insert}$ na przyłączu anteny odbiorczej, jak na Rys.2. Napięcie to można obliczyć ze wskazania miernika $U^{(a)}_{site}$. W



Rys. 2: Drugi krok w pomiarze NSA



Rys. 1: Pierwszy krok w pomiarze NSA

skali decybelowej wyraża się ono wzorem

2) $U^{(a)}_{insert} = U^{(a)}_{site} + CA^{(Rx)}$

Zgodnie z definicją tłumienia [7], różnica napięć z równań (1) i (2) jest tłumieniem środowiska *SA*

3) $SA^{(a)} = U_{ref} - U^{(a)}_{insert} = U_{direct} - U_{site}^{(a)}$

Tłumienie to [1] nie zależy od tłumienia żadnego z kabli, natomiast zależ y od uż ytych anten[2] . Dlatego nie jest ono przydatne w ocenie jakości stanowisk pomiarowych. Tylko tłumienie środowiska mierzone zawsze i wszędzie identycznym zestawem anten może posłużyć za weryfikator. W dokumencie [2] za taki zestaw uznano bezstratne anteny izotropowe

(4) $SA^{(i)} = U_{direct} - U^{(i)}_{site}$

Antena izotropowa, to pojęcie abstrakcyjne. Nie da się jej zbudować, ale tłumienie środowiska, wyrażone wzorem (3) da się przeliczyć na tłumienie jakie uzyskałoby się z wykorzystaniem anten izotropowych, wzór(4). W przeliczeniu tym trzeba się posłużyć pojęciem zysku energetycznego anteny G_i , zwanego również zyskiem kierunkowym lub po prostu zyskiem antenna gain, powierzchnią skuteczną anteny A_e *antenna's effective apperture (area)* oraz współczynnika an- teny *AF antenna factor* [4], [8].

Zysk kierunkowy anteny to stosunek gęstoś ci mocy w strefie dalekiej w kierunku największego promieniowania

[1] Zwróćmy uwagę, że wzór (3) wyraża tłumienie pod warunkiem że, generator, miernik sygnału oraz kable są do pasowane do impedancji odniesienia, którą jest zwykle rezystancja 50Ω. Tylko wtedy *SA* nie zależy od niedopasowania impedancyjnego na wejściach anten. W przeciwnym wypadku wzór (3) wyraża stratę wtrąceniową [7] środowiska, która jest funkcją odbic´ od impedancji wejściowych obu anten.

[2] Anteny są wnętrzem czwórnika. Możliwość przetworzenia sygnału prowadzonego kablem na pole wypromieniowane w przestrzeń, w przypadku anteny nadawczej oraz przetworzenia pola w przestrzeni na pole prowadzone kablem do miernika w przypadku anteny odbiorczej są indywidualnymi cechami anten, determinują- cymi mierzone tłumienie środowiska. Stąd górny indeks *(a)* w symbolu tłumienia.

[3] Dopasowanie polaryzacyjne oznacza takie ustawienie anteny w stosunku do pola, w którym napięcie zaindukowane w antenie jest największe. W przypadku dipola oznacza to ustawienie ramion dipola równolegle do linii natężenia pola elektrycznego.

anteny do gęstości mocy w strefie dalekiej bezstratnej anteny izotropowej, jeśli w obu przypadkach moc doprowadzona do anten *forward power* jest taka sama. Wyrażenie gęstoś ci mocy wektorem Poyntinga [8] oraz wykorzystanie zależności między modułami wektorów pola E i H w strefie dalekie daje związek między zyskiem anteny i modułami natężenia pola elektrycznego $E^{(a)}$, $E^{(i)}$ obu anten

5) $G_i = \frac{E^{(a)}}{E^{(i)}}^2$

W skali decybelowej wzór (5) ma postać

6) $G_{dBi} = 10 \log (G_i) = 20 \log \frac{E^{(a)}}{E^{(i)}}$

Symbolu *dBi* używa się dla zaznaczenia, że wielkoś cią odniesienia jest antena izotropowa.

Wyobraźmy sobie antenę odbiorczą umieszczoną w jednorodnym polu o module natężenia pola elektrycznego E dopasowaną polaryzacyjnie do pola[3] . Oznaczmy moc dostarczoną przez tę antenę do dopasowanego obciążenia (moc promieniowana˛ polem, przechwyconą przez antenę i wydzieloną w dopasowanym obciążeniu) symbolem P_o . Powierzchnię z jakiej antena musi przechwycić pole, aby dostarczyć do obciążenia tę moc nazywamy powierzchnią skuteczną anteny A_e

7) $P_o = \frac{E^2}{E_c} A_e$

przy czym Z_c jest impedancją charakterystyczną środowiska.

Powierzchnia˛ suteczne anteny izotropowej wyraz˙ a sie˛ wzorem $A_e = \frac{\lambda^2}{4\pi}$, w którym λ jest długoś cią fali.

Wyobraźmy sobie antenę odbiorczą umieszczoną w jednorodnym polu o module natężenia pola elektrycznego E dopasowaną polaryzacyjnie do pola. Jeżeli miernik o dopasowanej impedancji Z_o podłączony do przyłącza anteny wskazuje napięcie U_o, to stosunek E do U_o nazywamy współczynnikiem anteny AF

8) $AF = \frac{E}{U_o}$

W skali decybelowej jednostką współczynnika anteny jest $[dB(1/m)]$

W celu wyznaczenia zależności między współczynnikiem anteny AF, a zyskiem anteny G_i wyobraz´ my sobie antenę odbiorczą umieszczoną w jednorodnym polu o module natężenia pola elektrycznego E, dopasowaną polaryzacyjnie do pola. Moc wydzieloną na dopasowanym obciążeniu Zo tej anteny można wyrazić zależnością Uo^2/Zo. Z drugiej strony jest to moc przechwycona przez antenę, a więc iloczyn

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modułu wektora Poyntinga, powierzchni skutecznej anteny izotropowej oraz zysku anteny

9) $$\frac{U_o^2}{Z_o} = \frac{E^2}{Z_c} \cdot \frac{\lambda^2}{4\pi} \cdot G_i$$

po przekształceniach

10) $$\frac{E^2}{U_o} = AF^2 = \frac{4\pi}{\lambda^2} \cdot \frac{Z_c}{Z_o} \cdot \frac{1}{G_i}$$

ostatecznie

11) $$G_i = \frac{4\pi}{\lambda^2} \cdot \frac{Z_c}{Z_o} \cdot \frac{1}{AF^2}$$

Do dalszych rozważań przydatna będzie następująca postać wzoru (11) dla próżni, w której $Z_c = 120\pi\Omega$ oraz dopasowanego obciążenia $Z_o = 50\Omega$

12) $$\frac{\sqrt{1}}{G_i} = \frac{\lambda[\mathrm{m}]}{9,73} \cdot AF[1/\mathrm{m}]$$

Gdyby do pomiaru tłumienia środowiska komory użyć zestawu anten izotropowych, to wygenerowane natężenie pola w strefie dalekiej przez antenę nadawczą, zgodnie ze wzorem (5) byłoby $\frac{G^{(Tx)}}{i}$ razy mniejsze. Ponadto, z tego pola antena odbiorcza byłaby w stanie przechwycić $G_i^{(Rx)}$ razy mniej mocy zgodnie z definicją zysku anteny. Ostatecznie, napięcie pomierzone miernikiem $U_{site}^{(i)}$ byłoby $G_i^{(Tx)} \cdot G_i^{(Rx)}$ razy mniejsze

13) $$U_{site}^{(i)} = U_{site}^{(a)} \cdot \frac{1}{G_i^{(Tx)}} \cdot \frac{1}{G_i^{(Rx)}}$$

Korzystając ze wzoru (12) otrzymujemy

14) $$U_{site}^{(i)} = U_{site}^{(a)} \cdot AF^{(Tx)} \cdot AF^{(Rx)} \cdot \frac{\lambda}{9,73}^2$$

lub w skali decybelowej

15) $$U_{site}^{(i)} = U_{site}^{(a)} + AF^{(Tx)} + AF^{(Rx)} + 40\log\left(\frac{\lambda}{9,73}\right)$$

Wstawiając tę zależność do wzoru (4) otrzymujemy wzór na tłumienie środowiska mierzone antenami izotropowymi

16) $$SA^{(i)} = U_{direct} - U_{site}^{(a)} - AF^{(Tx)} - AF^{(Rx)} - 40\log\left(\frac{\lambda}{9,73}\right)$$

W dokumencie [2] jako znormalizowane tłumienie przyjęto tłumienie pomierzone antenami izotropowymi, wzór (16) przeskalowane tak, aby zniknął czynnik $40\log\left(\frac{\lambda}{9,73}\right)$, który nie zależy od użytych anten i jest niepotrzebnym balastem. Tak więc

17) $$NSA = U_{direct} - U_{site}^{(a)} - AF^{(Tx)} - AF^{(Rx)}$$

Jednostka NSA w skali decybelowej jest [$dB(\mathrm{m}^2)$].

W drugim kroku pomiaru tłumienia środowiska ustawia się antenę nadawczą w miejscu przewidzianym dla *EUT* w czasie badań oraz antenę odbiorczą w miejscu przewidzianym dla anteny odbiorczej w czasie badań. Utrzymując stałą wysokość anteny nadawczej zmienia się wysokość ustawienia anteny odbiorczej w przedziale od 1*m* do 4*m* i rejestruje największe wskazanie miernika $U_{site}^{(a)}$.

Pomiaru dokonuje się antenami dwustożkowymi, szerokopasmowymi lub antenami dipolowymi ze zmienną długością dipola, dla dwu polaryzacji - pionowej i poziomej. Anteny muszą być dopasowane polaryzacyjnie. Przy weryfikacji trzymetrowego stanowiska pomiarowego dla polaryzacji poziomej przy użyciu anten dipolowych ze zmienną długością dipoli wzór(17) należy skorygować współczynnikiem stabelaryzowanym w [2].

Dla stanowiska pomiarowego w przestrzeni otwartej pomiaru *NSA* dokonuje się tylko dla jednej pary punktów przestrzeni.

NSA w komorze częściowo bezodbiciowej weryfikuje się dla przestrzeni, w której w trakcie badań umieszczane jest *EUT*. Zwykle antenę nadawczą umieszcza się w pięciu punktach wyznaczających skrajnię *EUT*, przez co rozumie się zarys w kształcie cylindra, poza który nie wystają żadne elementy *EUT*, włączając w to przyłączone przewody.

Zgodnie z dokumentem [2] stanowisko pomiarowe w komorze częściowo bezodbiciowej bądź poligon pomiarowy nadają się do pomiaru emisji promieniowanej jeśli *NSA* pomierzone nie odbiega od teoretycznej wartości o więcej niż $\pm 4dB$ ($|\Delta NSA| \leq 4dB$). Rozbieżności tej, zgodnie z [2] nie można użyć jako współczynnika korekcji pomiaru, lecz należy uwzględnić w bilansie niepewności jako błąd graniczny.

Dominującymi źródłami niepewności pomiaru występującymi we wzorze (17) są niepewności wyznaczania współczynnika anteny nadawczej $AF^{(Tx)}$ oraz odbiorczej $AF^{(Rx)}$.

WSPÓŁCZYNNIK KOMORY I WSPÓŁCZYNNIK SZAROŚCI

W komorach z 3*m* stanowiskiem pomiarowy, w dolnym zakresie częstotliwości począwszy od 30*MHz*, antena pomiarowa znajduje się w sterfie bliskiej pola promieniowanego przez *EUT*. *NSA* mierzy się antenami pola elektrycznego. W strefie bliskiej pola *NSA* nie daje żadnej informacji o polu magnetycznym. Taką informację dają współczynnik komory oraz szarości.

W celu wyznaczenia współczynnika komory, mierzy się pole elektryczne w obrębie skrajni *EUT*, podobnie jak przy wyznaczaniu *NSA*, z czterema zasadniczymi różnicami:

- źródłem pola jest szerokopasmowy generator grzebieniowy (comb generator), a nie generator sinusoidalny,
- jako anteny nadawczej używa się oprócz elektrycznej anteny dipolowej, anteny pętlowej będącej anteną magnetyczną,
- odniesieniem pomiaru jest rzeczywisy, dobrej jakości poligon pomiarowy *OATS*, a nie zależności teoretyczne,
- anteną odbiorczą jest szerokopasmowa antena elektryczna.

Dla każdego punktu ustawienia anteny nadawczej, dla obu polaryzacji anten oraz obu rodzajów anteny nadawczej mierzy się anteną odbiorczą natężenie pola elektrycznego E_C w komorze. Następnie oblicza się współczynnik dewiacji komory chamber deviation factor *DF*

[4] *CF* dla pewnych częstotliwości może przyjmować w skali decybelowej wartości ujemne, co oznacza zawyżoną wartość pomiaru w stosunku do komory spełniającej wymogi dokumentu [2].

18) $DF\,[dB] = E_{OATS}\ dB\ \frac{\mu V}{m} - E_C\ dB\ \frac{\mu V}{m}$

w którym E_{OATS} jest natężeniem pola elektrycznego, pomierzonym w tych samych warunkach na poligonie odniesienia.

Jeżeli weryfikacji pola dokonuje się w pięciu punktach, to trzeba wyznaczyć 20 współczynników dewiacji *DF*, które są funkcją częstotliwości. Następnie oddzielnie dla każdej polaryzacji wyznacza się obwiednię górną i dolną współczynników dewiacji *DF* komory.

Współczynnik komory *CF* definiuje się dla każdej czę stotliwości i polaryzacji jako średnią arytmetyczną obwiedni górnej i dolnej dewiacji komory. Współczynnik szarości komory *GF* definiuje się dla każdej czę stotliwości i polaryzacji jako różnicę między współczynnikiem komory *CF*, a górną lub dolną obwiednią współczynników dewiacji *DF* komory.

Dokument [3] przewiduje dwa sposoby uwzględnienia współczynnika komory *CF*. Potraktowanie go jako wartości oczekiwanej i uwzględnienie jako poprawki w pomiarach[4] lub wyznaczenie dla każdej czę stotliwości i polaryzacji najgorszej z możliwych wartości współczynnika komory CF_{wc} worst case według wzoru

19) $CF_{wc}\,[dB] = CF\,[dB] + GF\,[dB]$

i użycie go jako poprawki. Wykorzystanie najgorszej z możliwych wartości współczynnika komory CF_{wc} penalizuje pomiar emisji E*UT*, ale daje gwarancję, że wartości pomierzone w komorze spełniającej wymagania dokumentu [2] na pewno nie będą większe.

Współczynnika szarości *GF* używa się jako błędu granicznego, przypisując mu rozkład prostokątny, jako z˙ e istnieje jednakowe prawdopodobieństwo, że prawdziwa wartość mierzonego natężenia pola znajduje się w jednym z punktów między obwiedniami.

Aby komory można było używać do pomiarów, współczynnik komory *CF* musi być z przedziału ±10*dB*, a współczynnik szarości komory *GF* musi być mniejszy niż 5*dB*.

WNIOSKI

Wyprowadzone w artykule wzory na znormalizowane tłumienie środowiska pomiarowego wyjaśniają pochodzenie przymiotnika "znormalizowany". Normalizacja polega na wyznaczaniu tłumienia środowiska zawsze i wszędzie zestawem anten izotropowych.

Komory częściowo bezodbiciowe nie spełniające warunku $|\Delta NSA_{SAC}| \leq 4dB$ można mimo tego używać do pomiarów emisji promieniowanej. W tym celu trzeba pomierzyć współczynnik komory *CF* oraz współczynnik szarości *GF*. Pierwszy z nich wykorzystuje się w pomiarach emisji *EUT* jako poprawkę, drugi jako błąd graniczny.

LITERATURA

- [1] A. Askri, C. Vollaire, L. Nicolas, D. Prebet: *Normalized Site Attenuation Standard Correction From Numerical Computing. IEEE Trans. on Magnetics, Vol. 38, No.2*, March 2002.
- [2] CISPR 16-1-4:2004 + A1:2005 + A2:2005: Specification for ra- dio disturbance and immunity measuring apparatus and meth- ods - Part 1-4: Radio disturbance and immunity measuring ap- paratus - Ancil- liary equipment - Radiated disturbances. *IEC*, 2005.
- [3] CENELEC R110-003: Guidelines on how to use anechoic enclo- sures that do not fulfill the requirements regarding nor- malized site attenuation for pre-compliance tests of products. *CENELEC*, 1995.
- [4] http.//www.antenna-theory.com/definitions
- [5] IEC 60050-International Electrotechnical Vocabulary-www.electropedia.org
- [6] I. H. Hubing: Correcting radiated emission data measured in noni- deal environments. IEEE Trans. *EMC, Vol. EMC-28, No.2*, May 1986.
- [7] J. Sroka, *Niepewność pomiarowa w badaniach EMC, pomiary emisyjności radioelektrycznej* . OWPW, Warszawa, 2009.
- [8] J. Szóstka: Fale i anteny. *WKŁ*, Warszawa 2006.

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Het Lichtnetdistributienetwerk, Netfilters en Power Line Communicatie … een Basis Voor Incompatibiliteit?

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Het lichtnetdistributienetwerk is oorspronkelijk bedoeld om elektrische energie te distribueren, dit bij 'n lichtnetfrequentie, van de elektriciteitscentrales naar de eindgebruikers. Het driefasige laagspannings-lichtnetdistributienetwerk kan efficiënter worden benut als een power factor van 1 wordt bereikt en er geen harmonische vervorming op wordt gegenereerd. Als gevolg van een toename van de zelf-opgewekte energie bij de eindgebruikers en het tot verzadiging stijgende toename van schakelende elektronica, wordt het lichtnetdistributienetwerk steeds zwaarder getroffen. Ditzelfde lichtnetdistributienetwerk wordt nog steeds overwogen voor power line communicatie (PLC), dit in twee frequentiebanden: de onderste, 10 kHz - 150 kHz (EN 50065), en een van 1,6 MHz tot 30 MHz (b.v. HomePlug, IEEE 1901, EN 50412-2-1: 2005 + corrigendum Feb. 2009 en EN 50561-1:2013)).

LICHTNETDISTRIBUTIENETWERKKWALITEIT

DE LICHTNETDISTRIBUTIENETWERKKWALITEIT bepaalt de geschiktheid van het lichtnetdistributienetwerk voor de apparaten bij de eindgebruiker. Een synchronisatie van de spanning, frequentie en fase maakt dat elektrische systemen in hun beoogde wijze kunnen functioneren zonder een significant verlies van hun prestaties en/of levensduur. De term 'lichtnetdistributienetwerkkwaliteit' (Eng: power quality) wordt gebruikt om elektrische energie die een elektrische of elektronische belasting gebruikt en waarmee deze belasting goed kan functioneren te beschrijven. Zonder de juiste voeding zal een elektrisch apparaat (of belasting) mogelijk niet goed, snel(ler) defect gaan of helemaal niet werken. Er zijn vele manieren waardoor elektrische energie van slechte kwaliteit kan zijn en er zijn nog veel meer oorzaken dat deze kwaliteit verder afneemt. Door de eindgebruikers wordt echter algemeen aangenomen dat de elektrische energie 24/7 wordt geleverd en in staat is om op ieder moment de verwachte hoeveelheid elektrisch vermogen te kunnen leveren.

De elektrische energie-industrie bestaat elektrische energieproductie (wisselstroom), de transmissie van elektrische energie en uiteindelijk de lokale distributie van de elektriciteit die via de elektriciteitsmeter binnenkomt bij de eindgebruiker. De elektrische energie vloeit dan door het lokale lichtnetdistributienetwerk: bedrading van de installatie van de eindgebruiker, totdat een belasting wordt bereikt. De complexiteit van

het elektrische systeem om elektrische energie transporteren vanaf het punt van productie tot het punt van het verbruik is tegenwoordig afhankelijk van de variatie van het weer: PV (fotovoltaïsch) en windenergie en de veranderende vraag en aanbod en alle andere factoren bieden veel mogelijkheden waardoor de lichtnetdistributienetwerkkwaliteit wordt aangetast of tenminste wordt beïnvloed.

Terwijl de 'power quality' is een handige term is voor velen, is het meestal de kwaliteit van de spanning - in plaats van kwaliteit van de elektrische stroom - die daadwerkelijk door deze term beschreven wordt. Maar het is gewoon de kwantiteit van energie en de daaruit volgende stroom door een belasting die grotendeels oncontroleerbaar geworden is.

Idealiter wordt de netspanning aangeleverd vanuit een energiecentrale die als een signaalbron met een sinusvormige amplitude en frequentie voldoet aan de nationale normen en waarbij de signaalbron een impedantie 'nul' Ohm heeft bij alle frequenties. Het reële elektriciteitsnet is niet ideaal en zal afwijken op de volgende manieren:

• Variaties in de piek- of de RMS-spanning zijn belangrijk voor verschillende soorten apparatuur. Wanneer de RMS spanning hoger is dan de nominale spanning van 10 tot 80 % voor een ½ netspanning periode tot 1 minuut dan wordt de gebeurtenis een 'swell' genoemd. Een 'sag' is de omgekeerde situatie: de RMS -spanning is dan lager dan de nominale spanning van 10 tot 90 % voor een ½ netspanning periode tot 1 minuut. Echter, in de Verenigde Staten is het gebruikelijk dat spanningsdips of het uitvallen van de netspanning een 'sag' wordt genoemd.

• Willekeurige of herhaalde variaties van de RMS-spanning tussen 90 en 110 % van de nominale kan het fenomeen 'flicker' in verlichtingsapparatuur produceren. Flicker is waarneembaar als snelle zichtbare veranderingen van het lichtniveau. Een omschrijving van de kenmerken van deze spanningsschommelingen die flikkerend licht produceren is het onderwerp van lopend onderzoek. Met solid-state lichtbronnen treedt dit fenomeen nauwelijks op.

• Abrupte, een op zeer korte termijn toenemen van de netspanning, zijn: 'spikes', impulsen, of pieken, meestal veroorzaakt door het inschakelen van grote capacitieve belastingen of veroorzaakt door grote inductieve belas tingen die worden uitgeschakeld. Zelfs in meer ernstig mate door directe of indirecte effecten van blikseminslag.

• Onderspanning is wanneer de nominale netspanning beneden de 90 % is gedurende meer dan 1 minuut. De term onderspanning is een passende omschrijving voor de netspanning die daalt ergens tussen vol vermogen (= fel licht) en een 'black-out' (= geen vermogen = geen licht). Het komt tot uiting bij het aanzienlijke dimmen van gewone gloeilampen, tijdens systeemfouten of over belasting enz., als er te weinig stroom beschikbaar is om de gewenste helderheid te bereiken in (meestal) huis houdelijke verlichting. Deze term heeft geen formele definitie, maar wordt vaak gebruikt om een verlaging van het netspanning te beschrijven die door 'n pro gramma van de lichtnetbeheerder aangeeft dat de vraag moet worden verlaagd of om het lichtnetdistributienetwerken in z'n operationele marges te verhogen.

• Overspanning treedt op wanneer de nominale spanning stijgt tot boven 110 % gedurende meer dan 1 minuut.

• Variaties in de fundamentele netfrequentie, deze ligt meestal binnen ± 2 % van de nominale waarde en het to taal aantal netperioden ligt over 24 uur vast (i.v.m. synchrone uurwerken).

• Variaties in de golfvorm - gewoonlijk als harmonischen - en de spanningsvervorming als gevolg van verzadigingseffecten in de lichtnettransformatoren door AC/DC gelijkrichter doordat deze schakelaars tweemaal in een netperiode (eenfasige toepassing) sluiten op de top van de piekspanning.

• Er zijn veel meer oorzaken voor harmonische en interharmonische vervorming dan alleen magnetische verzadiging - bijvoorbeeld fluorescentielampen met magnetische of solid-state voorschakelapparaten kunnen dit als gevolg van de schakelingfrequenties die hierin worden gebruikt. In het algemeen worden problemen veroorzaakt door alle schakelingen met elektronische belastingen en schakelende elektronische bronnen die gekoppeld zijn aan het lichtnet. Elke vorm van consu mentenelektronica lijkt te komen met een plug-in batterijlader die op zich weinig stroom verbruikt, maar door zijn enorme aantallen zal hun totale effect groot zijn. Frequentieregelaars, voor motor drives als variabele snelheid regelaars voor AC-motoren, of voor het genereren van een netfrequentie vanuit een alternatieve energiebron zoals een PV-installatie of windturbine maken andere storingen op frequenties lager dan 150 kHz. Ze worden inter-harmonischen genoemd omdat ze zijn niet (fase-)gelinkt zijn aan de netfrequentie.

• De niet-nul zijnde laagfrequente complexe impedantie van de netspanningsbron: door de midden- naar laagspanning transformator en de bedrading zal er een impedantie worden gevormd naar apparaten van de eindgebruiker (hierdoor zal, indien een belasting meer stroom trekt de effectieve netspanning over de belasting, t.g.v. deze impedantie, dalen.

• De niet-nul zijnde hoogfrequent complexe impedantie van de netspanningsbron: wanneer een belasting instantaan vraagt om een grote hoeveelheid energie of hij stopt met de vraag van energie dan zal er een dip of piek op de netspanning optreden als gevolg van de inductie c.q. karakteristieke impedantie van het lichtnetdistributienetwerk. Ook met continue schakelbelastingen: UPS, PWM, solid-state verlichtingsbesturingen, etc. wordt verwacht dat de lichtnetimpedantie laag is maar kan deze hoog zijn als gevolg van resonanties die op het lichtnetdistributienetwerk optreden.

• Actieve Power Factor Corrector (PFC). Door een actieve power factor controller, wordt de totale netstroom die door een groep belastingen wordt getrokken gemeten en m.b.v. condensatorbanken die hieraan parallel geschakeld worden, op een zodanige wijze dat de totale power factor zo dicht mogelijk bij 1 blijft, bij de voedingstransformator gecorrigeerd.

Omdat het lichtnetdistributienetwerk in allerlei vormen: parallel en/of vertakt en al in het gebouw of terrein van een eindgebruiker als parallel lopende geleiders is gedistribueerd, kan het ook gebruikt worden als transmissielijn. Daarbij is het formele gebruik van het lichtnetdistributienetwerk door het lichtnet harmonische signalen, uitgebreid met een aantal harmonischen: ≤ 40 harmonische overwogen. De hogere frequenties ≥ 10 kHz worden (werden) verwacht vrij te zijn om te gebruiken voor power line communicatie doeleinden.

LICHTNETSPANNING-VERONTREINIGING EN LICHTNETIMPEDANTIE

Zowel de publieke als de industriële lichtnetdistributienetwerken worden zwaar getroffen door allerlei schakelelektronica die, omwille van het moeten voldoen aan formele RF- emissie eisen, zijn voorzien van netfilters met grote (X-type) condensatoren op hun lichtnet-aansluiting. Het tussen-

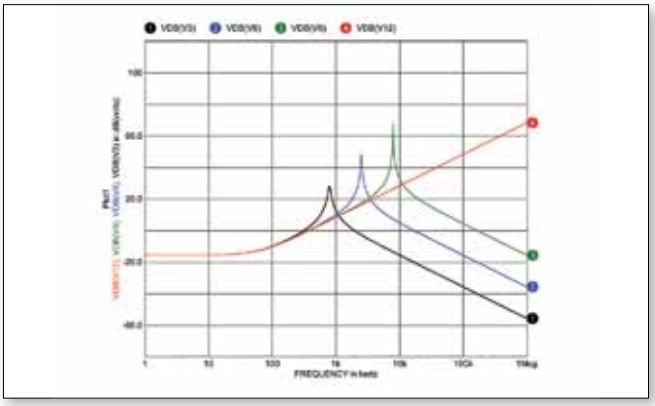
liggende frequentiebereik tussen de 40e harmonische van de netfrequentie: ~ 2 kHz en 150 kHz (daar waar de EMC-eisen van toepassing worden) is op dit moment niet gedefinieerd. Aan de geleide RF emissie zijde zijn geen eisen in ontwikkeling, dit afgezien van de RF- emissie-eisen die vanaf 9 kHz van toepassing zijn voor elektrische verlichting: IEC/EN 55015. Als zodanig zijn: actieve omvormers (AIC), onderbrekingsvrije voedingen (UPS), pulsbreedte gemoduleerd (PWM) AC/AC en AC/DC- convertors en aandrijvingen en andere schakelende benodigdheden, regulatoren en controllers onbegrensd met wat betreft hun geleide RF-emissie. Niveaus tot 30 Volt zijn gemeten in dat frequentiegebied. In dit geval is het onduidelijk tegen welke lichtnetimpedantie deze hoge stoorspanning is gemeten en deze zou samengevallen kunnen zijn met resonanties in het lichtnetdistributienetwerk.

Een netfilter met X-type condensatoren blokkeert de transmissielijn eigenschappen van het lichtnet-distributienetwerken zoals deze zijn vereist voor de power line communicatie (PLC). In combinatie met de effectieve secundaire inductantie van de midden-naar-laagspanning transformator, evenals de lichtnetdistributienetwerk bekabeling er tussen in, zullen circuit resonanties optreden vanaf enkele honderden Hz-en. Indien er een actieve vermogensfactor correctie wordt gebruikt door het schakelen van condensatoren parallel aan de drie fasen van het lichtnet dan kan de effectieve impedantie van het wandcontactdoor veranderen van inductief naar capacitief, althans voor hogere frequenties.

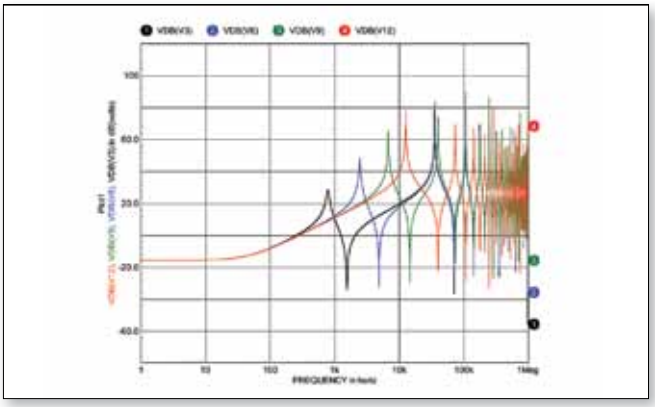
In IEC 61000-3-3 worden de waarden van de lichtnetimpedantie bij 50/60 Hz gegeven voor lichtnet-distributienetwerken met een stroom van 16 ampère/fase als maximum. De impedantiewaarden: 0,24 + j 0,15 Ω worden gegeven voor de fasedraden en de impedantie voor de neutrale is iets minder: 0,16 + j 0,10 Ω. Voor een TN-S systeem is de neutrale draad verbonden aan de PE-aansluiting op de transformator. Dit resulteert in een effectieve inductie aan de secundaire zijde van transformator van 400-500 µH voor de fase draden naar PE. Bij hoogvermogen transformatoren zal het weerstandsdeel van de lichtnetimpedantie dalen omdat de inductie wordt gegeven door de parasitaire inductie van de transformator en enige bedrading er tussen. Wanneer men een capaciteit van 100(v3), 10(v6), 1(v9) µF of 0(v12) parallel aan een dergelijke wisselstroombron verbindt dan worden de totale lichtnet-distributienetwerk impedanties (20•log10|Z|) als functie van de frequentie gegeven in figuur 1.

Zoals blijkt uit figuur 1, kunnen lichtnetimpedantie resonanties van minder dan 1 kHz zich voordoen. Bovendien daalt de AC bronimpedantie boven de parallelle resonantiefrequentie als gevolg van de ideale power factor correctie (PFC) condensator die is aangebracht. Bij een lichtnetdistributienetwerk wordt de laagspanningslichtnet afgetakt van de midden-naar-laagspanning transformator en naar de diverse (gebouw) belastingen met daarin afzonderlijke belastingen/energiegebruikers. Deze energiegebruikers hebben ieder hun eigen complexe impedantie als functie van de frequentie en deze takken van het lichtnetdistributienetwerk kunnen in lengte verschillen van enkele meters tot kilometers lang.

Zoals blijkt uit figuur 2 wordt het aantal resonanties dat optreedt aan het einde van een afgeschermde lichtnetdistributienetwerkkabel met een karakteristieke impedantie van 20 Ω hoog. Bij een kabellengte van 1 km zijn er zoveel resonantiefrequenties die je niet op je lokale lichtnetdistributienetwerk



FIGUUR 1: Lichtnetimpedantie [dBΩ] als functie van de frequentie wanneer PFC condensatoren worden gebruikt parallel aan een transformator.



FIGUUR 2: Lichtnetimpedantie [dBΩ] als functie van de frequentie wanneer PFC condensatoren worden gebruikt parallel aan een transformator bepaald na 1 km kabel.

wilt hebben en kun je hier alleen vanaf komen door lokale impedantiescheiding toe te passen bij de binnenkomende kabel bij de energiemeter. Dit eenvoudige maar realistische voorbeeld laat zien dat het gebruik van PFC condensatoren in combinatie met het gebruik van PLC niet mogelijk is.

Vanuit een RF transmissielijn oogpunt moet de differentiële karakteristieke impedantie van lokale lichtnetdistributienetwerk liggen tussen 20 en 150 Ω (= 26 - 44 dBΩ). Deze karakteristieke impedantie wordt bepaald door de geometrie van de dwarsdoorsnede van het lichtnetbekabeling (max. 5 draden in een buis) versus hun omgeving. Een afgeschermde VMvKas kabel zal een lage karakteristieke impedantie opleveren: ~20 Ω. Voor twee of drie 2,5 mm2 afzonderlijk geïsoleerde draden in een 5/8 PVC-buis in beton zal dit een hogere karakteristieke impedantie opleveren: 150 Ω. Een voordeel van de vermogenskabels die zijn afgeschermd is de lage RF-verliezen die optreden als gevolg van het ontbreken van enige stralingsweerstand verliezen. Het nadeel hiervan is het ontbreken van enige RF-demping en de steile onbegrensde resonanties die dan kunnen optreden.

In figuur 3 wordt het effect weergeven als de PFC condensatoren worden toegepast aan de belasting zijde, lokaal bij de eindgebruiker. De lokale lichtnetimpedantie wordt volledig overruled (naar beneden gebracht) door de ideale PFC condensatoren en alle lichtnetimpedantie resonanties op de lichtnetbekabeling lijken verdwenen door de lage lichtnetimpedantie die lokaal wordt waargenomen. Dit betekent echter niet dat het totale lichtnetdistributienetwerk vrij is van resonanties.

Vanwege de lokale toepassing van de PFC condensatoren bij de gebruiker zullen de resonanties optreden als stroomresonanties tussen de PFC condensatoren en het lichtnetdistributienetwerk naar de transformator, zie figuur 4. De resonanties blijven bestaan tussen de PFC condensatoren en de transformator op 1 km afstand. De stoorspanningen/stromen zullen worden gepropageerd langs het lichtnetdistributienetwerk tot aan de transformator en zal dan verder via de verschillende lichtnetdistributienetwerktakken doorgegeven worden aan de andere gebruikers en tot ernstige overspraak leiden.

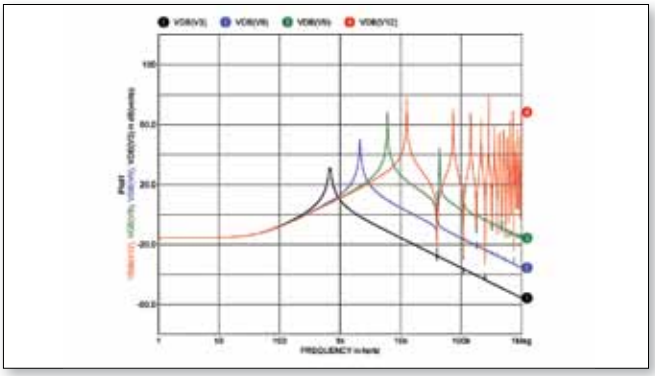
AFSTEMMEN OF ONTSTEMMEN

Omwille van het optimaliseren van het energie-efficiënte gebruik van het lichtnetdistributienetwerk op de operationele netfrequentie moet de arbeidsfactor worden geoptimaliseerd (afgestemd) om deze op '1' te krijgen. Omwille van het vermijden van resonanties op lichtnetdistributienetwerken moet er RF-lossy filtering worden toegepast om de kwaliteitsfactor bij de resonantiefrequenties te verlagen. Als zodanig worden vermogensverliezen opzettelijk geïntroduceerd bij de hogere frequenties. Hierdoor is het impedantiegedrag op het lichtnetdistributienetwerk beter te beheersen. Bovendien heeft de toegepaste lichtnetfiltering als functie dat de lichtnetimpedantie resonanties niet samenvallen met de werk-frequenties die in de AIC, UPS, PWM en andere schakelende regelaars worden toegepast.

In een actuele huishoudelijke omgeving zullen 50 of meer schakelende apparaten zijn verbonden met de plaatselijke lichtnetdistributienetwerk. Niet allemaal tegelijkertijd en niet allemaal met dezelfde impact op het stoorniveau of de lichtnetdistributienetwerk impedantie. Elke batterijlader, PC, laptop, tv, multimedia center zal zijn een eigen switch-mode voeding (SMPS) hebben. Elke solid-state gedreven LED of TL controller zal schakelend zijn en alle van hen hebben een ingebouwde netfilters met X- en/of Y- condensatoren aan de netzijde die het lichtnetdistributienetwerk lokaal beïnvloeden. Er zijn geen lichtnet poort impedantie eisen gegeven anders dan dat zij ervoor moeten zorgen dat het apparaat met netfilter voldoet wanneer deze gemeten wordt tegen een gestandaardiseerde kunstnetwerkimpedantie van 50 Ω parallel aan (50 µH + 5 Ω), dit voor het frequentiebereik van 150 (of 9) kHz tot 30 MHz. Aan de andere kant wordt er (nog) geen aandacht besteed aan wat er zal gebeuren met de lichtnetverstoring als de 'echte' lichtnetimpedantie te veel afwijkt van de gestandaardiseerde waarden of wanneer er meerdere apparaten parallel worden gebruikt.

Wanneer alle '50' reactieve netfilters met elkaar zijn verbonden door middel van het lokale lichtnetdistributienetwerk, dan zal dit resulteren in een woud van resonanties: $2^{(50-1)}$ die de power line communicatie onmogelijk zal maken. Toch worden er commercieel PLC modems (in de hogere band) aangeboden met een data-overdracht van meer dan 200 Mb/s met discutabele prestaties.

Als PLC formeel wordt toegestaan (geratificeerd Oktober 2013) en bevorderd met gegarandeerde prestaties, dan moet er een minimum aan de effectieve lichtnetdistributienetwerk impedanties en een minimum aan de belastings-impedanties worden gesteld. Dit om een gecontroleerde PLC communicatie mogelijk te maken via het lichtnetdistributienetwerk als medium. Verder moet er een maximale kanaal/pad demping worden gedefinieerd tussen verschillende wandcontactdozen



FIGUUR 3: Lichtnetimpedantie [dBΩ] als functie van de frequentie waarbij de PFC capaciteiten lokaal aan de belasting zijde worden toegevoegd, aan het einde van 1 km kabel

waartussen PLC zal naar verwachting worden gebruikt, dit onder gegeven RF- bron en RF belastings-impedanties. Een internationale standaardisatie voorbeeld is IEC 61334, distributie-automatisering met behulp van de distributie line carrier systemen - een standaard voor low - speed betrouwbare power line communicatie door elektriciteit meters, watermeters en SCADA. De meeste van de PLC standaarden en protocollen zijn industrie gedreven als DC-BUS, HomePlug Powerline Alliance, HomePNA, IEEE 1901, IEEE 1675-2008, KNX is een gestandaardiseerde (EN 50090, ISO/IEC 14543), OSI-gebaseerd netwerk communicatie protocol voor intelligente gebouwen), LonWorks, Multimedia over Coax Alliance, Residential gateway, Universal Powerline Association, enz.

Ten tweede, met een niet-voorspelbare lichtnetimpedantie betekent dit dat het maken van verstoringen en de propagatie hiervan langs het lichtnetdistributienetwerk onvoorspelbaar is, tenzij er impedantie en netfilter maatregelen worden genomen op het punt van binnenkomst van de lichtnetaansluiting. Het netimpedantie voorstel zoals beschreven in IEC 61000-4-7 is niet geschikt voor normalisatie. Het vaststellen van internationaal overeengekomen lichtnetmeetimpedantie tussen alle betrokken werkgroepen is een eerste stap om tot een kwantificeren en kwalificeren van de gegenereerde verstoringen door de aangesloten apparaten en systemen te komen. In het frequentiegebied van 2-150 kHz, wordt een 1 of 10 Ω differentiële impedantie gepromoot in een alternatief ontwerpdocument voor IEC 61000-4-19. Voor de lagere lichtnet-harmonische frequenties bestaan normen: IEC 61000-3-2 voor apparaten tot 16 ampère/fase en IEC 61000-3-12 voor apparaten tot 75 ampère/fase waarbij moet worden benadrukt dat alleen op de lichtnetfrequentie deze impedanties gedefinieerd zijn.

Tot dusver is er geen consensus bereikt over de noodzaak van regulering van storingen in deze frequentieband 2-150 kHz. Deze band wordt beschouwd als de 'vuilnis' band en wordt beschouwd als noodzakelijk voor de elektronica om zowel te voldoen aan de lagere frequente eisen: ≤ 40 netharmonischen en aan de EMC-eisen boven 150 kHz. De economische impact wordt voorgesteld als een gruwel voor de industrie over de nodige maatregelen moeten worden genomen. Foutieve uitlezingen en onbedoelde reacties zijn bekend uit lekstroom beveiligers (RCB) en elektriciteitsmeters waarvoor nu immuniteitseisen in ontwikkeling zijn bij IEC TC77A. Er zijn geen eenvoudige retrofit maatregelen bekend om de bestaande impedantieresonanties in bestaande lichtnetdistributienetwerken te verhelpen en de resonantie-effecten die

ontstaat door meervoudige reactieve belastingen (op de hogere frequenties) te kunnen onderdrukken. Hierdoor kan de gewenste co-existentie tussen PLC en het lichtnetdistributienetwerk nu niet worden gewaarborgd.

De werkelijke problemen omtrent de lichtnetdistributienetwerk en de daar aanwezige verstoringen onder de 150 kHz zijn verontrustend. Vanuit CENELEC commissie SC205 is op dit moment een verslag te vinden:
http://bit.ly/1a5hyiU

Verschillend van de huidige lichtnetdistributienetwerk-kwaliteit-aanpak waarbij de lichtnetspanning primair wordt gecontroleerd en dat het gedrag van het lichtnetdistributienetwerk slechts een gevolg is, is slechts deels waar. Veel van het lichtnetdistributienetwerk resonanties zijn zelf gegenereerd door voornamelijk reactieve componenten te gebruiken bij power factor correctie als bij netfiltering en door de vele apparaten die worden aangesloten en de kabellengten ertussen.

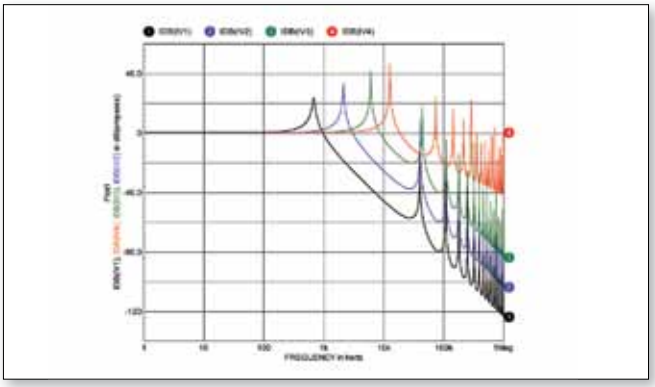
CONCLUSIES

Op internationaal normalisatieniveau: IEC TC22, TC77A en op Europese reguleringsniveau (CENELEC SC205) zijn enorme debatten gaande. Op dit moment wil men vanaf overheidswege slimme meters, met PLC, bevorderen. Vanwege de onaanvaardbare prestaties op het gebied van deze slimme meters, met PLC-interfaces, wordt dit initiatief belemmerd. Als alternatief, bijvoorbeeld in het Verenigd Koninkrijk en Duitsland, zullen daar de meeste slimme meters worden uitgerust met draadloze communicatie.

Wanneer de slimme meters, met of zonder PLC als een interface, niet op korte termijn beschikbaar komen, dan kan de zelf opgewekte energie: PV, wind, enz. niet economisch betrouwbaar worden teruggekoppeld naar het lichtnetdistributienetwerk. Beide partijen aan beide kanten van het lichtnetdistributienetwerk i.h.b. de energiemeter willen betaald krijgen voor wat ze hebben verwacht te hebben geleverd.

Het gebruik van PLC als een betrouwbare communicatiekanaal voor consumenten of voor industriële gebieden wordt bepaald door een groot aantal parameters die misschien zelfs buiten de span of controle van de eindgebruiker vallen en welke ook nog variëren gedurende de dag.

Tot op heden zijn er nog geen internationale activiteiten gestart voor het opstellen van eisen t.a.v. de lichtnetimpedantie variabiliteit noch op de RF-impedantie die een op een wandcontactdoos aangesloten apparaat mag vertegenwoordigen in de richting van het lichtnetdistributienetwerk. Immuniteit eisen zijn in ontwikkeling: IEC 61000-4-16 en 19 (IEC TC77A), maar op basis van indirect bewijs, zoals het niet meenemen van de lichtnetdistributienetwerk impedanties tijdens de stoorspanning dataverzameling. Als zodanig holt de internationale standaardisatie achter de feiten aan, niet in staat of niet welwillend om gelijke tred te houden met de technologische ontwikkelingen.



FIGUUR 4: De genormaliseerde stroom [dBA] door de transformator als functie van de frequentie waarbij de PFC capaciteiten lokaal aan de belasting zijde worden toegevoegd, aan het einde van 1 km kabel.

REFERENTIES IN EEN SYSTEMATISCHE VOLGORDE:

- EN 50065, Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz. General requirements, frequency bands and electromagnetic disturbances, 2011, CENELEC, www.cenelec.eu
- EN 50160, Voltage characteristics of electricity supplied by public distribution networks, 2010, CENELEC, www.cenelec.eu
- EN 55011/ IEC CISPR 11, Industrial, scientific and medical (ISM) radio-frequency Equipment Electromagnetic disturbance characteristics. Limits and methods of measurement, 2007, CENELEC, www.cenelec.eu or 2009, webstore.iec.ch
- IEC 61000-2-5, Electromagnetic compatibility (EMC): Environment - Description and classification of electromagnetic environments, 2011, webstore.iec.ch
- IEC 61000-3-2, Electromagnetic compatibility (EMC): Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase), 2005, webstore.iec.ch
- IEC 61000-3-12, Electromagnetic compatibility (EMC): Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase, 2011, webstore.iec.ch
- IEC 61000-4-13, Electromagnetic compatibility (EMC): Testing and measurement techniques - Harmonics and interharmonics including mains signalling at a.c. power port, low frequency immunity tests, 2009, webstore.iec.ch
- IEC 61000-4-16, Electromagnetic compatibility (EMC): Testing and measurement techniques - Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz, 2011, webstore.iec.ch
- IEC 61000-4-17, Electromagnetic compatibility (EMC): Testing and measurement techniques - Ripple on d.c. input power port immunity test, 2009, webstore.iec.ch
- IEC 61000-4-19, Electromagnetic Compatibility (EMC): Testing and measurement techniques - Test for immunity to conducted, differential mode disturbances in the frequency range from 2 kHz to 150 kHz, at a.c. ports, 2012, committee draft, webstore.iec.ch
- IEC 61800-3, Adjustable speed electrical power drive systems – Part 3: EMC product standard including specific test methods, 2004, webstore.iec.ch
- IEC 61800-5-1, Adjustable speed electrical power drive systems – Part 5-1: Safety requirements -electrical, thermal and energy, 2007, webstore.iec.ch
- IEC 62040-1, Uninterruptible power systems (UPS) – Part 1: General and safety requirements for UPS, 2008, webstore.iec.ch
- IEC 62040-2, Uninterruptible power systems (UPS) – Part 2: Electromagnetic compatibility (EMC) requirements, 2005, webstore.iec.ch
- IEC 62103, Electronic equipment for use in power installations, 2003, webstore.iec.ch
- http://www.iec.ch/about/brochures/pdf/technology/transmission.pdf

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Gebruik van de Resonantiekamer bij het Meten van het Totale Uitgestraalde Vermogen Voor EMV-toetsing

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Samenvatting - Multimediaproducten moeten voldoen aan eisen bedoeld om blootstelling aan elektromagnetische velden (EMV) te beperken. Naleving hiervan kan worden aangetoond door middel van het laagvermogencriterium, door te bewijzen dat het totale uitgestraalde vermogen lager is dan 20 mW. Deze publicatie beschrijft de meetmethode die ontwikkeld is om het maximale totale uitgestraalde vermogen te meten met behulp van de resonantiekamer. Er wordt zowel een beschrijving van de kalibratie van de kamer gegeven als van de verificatie van de meetmethode. Tenslotte worden er enige meetresultaten van daadwerkelijke multimediaproducten gegeven.

I. INLEIDING

MULTIMEDIA (MM) producten moeten voldoen aan eisen bedoeld om de blootstelling van mensen aan elektromagnetische velden (EMV) te beperken. Omdat er geen specifieke EMV-norm bestaat voor MM-producten, kan de generieke EMV-norm IEC 62311 [1] worden toegepast om naleving van de eis aan te tonen. Vanwege het algemene karakter van [1] biedt deze norm geen specifieke toetsingsmethoden, d.w.z. dat er in deze norm geen technische details betreffende mogelijke testmethoden om EMV-naleving te toetsen worden beschreven. Daarom is er een product-specifieke norm voor MM-producten ontwikkeld, welke is gepubliceerd als een technisch rapport van de ECMA [2]. Dit technische rapport geeft gedetailleerde instructies voor de toetsing van de blootstelling aan EMV van de bevolking in het algemeen door MM-producten overeenkomstig [1].

De limieten aan EMV-blootstelling, ook wel de 'basisbeperkingen' genoemd, staan vermeld in de ICNIRP 1998-richtlijnen [3] en zijn gebaseerd op vastgestelde effecten op de gezondheid. De basisbeperkingen worden gespecificeerd met behulp van verschillende grootheden in verschillende frequentiebereiken. Deze zijn gebaseerd op de diverse negatieve effecten op de gezondheid die kunnen worden veroorzaakt door EMV-blootstelling in dat speci-

fieke frequentiebereik.

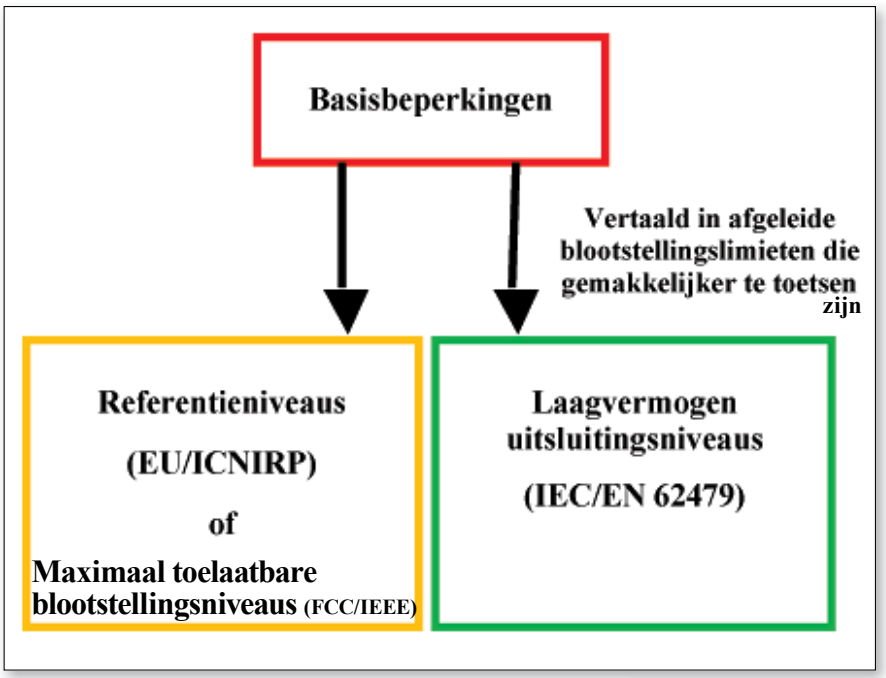
De grootheden waarin de basisbeperkingen zijn gespecificeerd, zijn vaak niet erg praktisch om te meten, wat het aantonen van naleving van de regels ingewikkeld maakt. Om de nalevingsmetingen te vereenvoudigen zijn er alternatieve limieten, 'referentieniveaus', vastgesteld. Referentieniveaus corresponderen met de basisbeperkingen onder blootstellingsomstandigheden in de slechtste gevallen en worden gedefinieerd in gemakkelijker meetbare hoeveelheden, zoals elektrische veldsterkte (E), magnetische veldsterkte (H), magnetische fluxdichtheid (B), vermogensdichtheid (S) enz.

Naast het gebruikmaken van de basisbeperkingen en de referentieniveaus voor het aantonen van naleving van de norm is het wellicht ook mogelijk om nalevingscriteria te baseren op realistische aannames, bijvoorbeeld dat een eenvoudige meting gebruikt kan worden om naleving aan te tonen. Deze aanpak wordt overwogen in [1] waar vermeld wordt dat als de geteste apparatuur (EUT; Equipment Under Test) aantoonbaar voldoet aan zowel de bedoelde als de onbedoelde emissies volgens de generieke laagvermogennorm IEC 62479 (d.w.z. gemiddeld totaal uitgestraald vermogen ≤ 20 mW) [4], dan moet ervan worden uitgegaan dat ook wordt voldaan aan de EMV-eisen in [1]. Deze laagvermogenlimiet van 20 mW is een zeer conservatieve limiet die is gebaseerd op de SAR-limiet van 2 W/kg die van toepassing is op elke 10 gram voxel* hersenweefsel. U treft een overzicht van de typen EMV-blootstellingslimieten aan in Afb. 1.

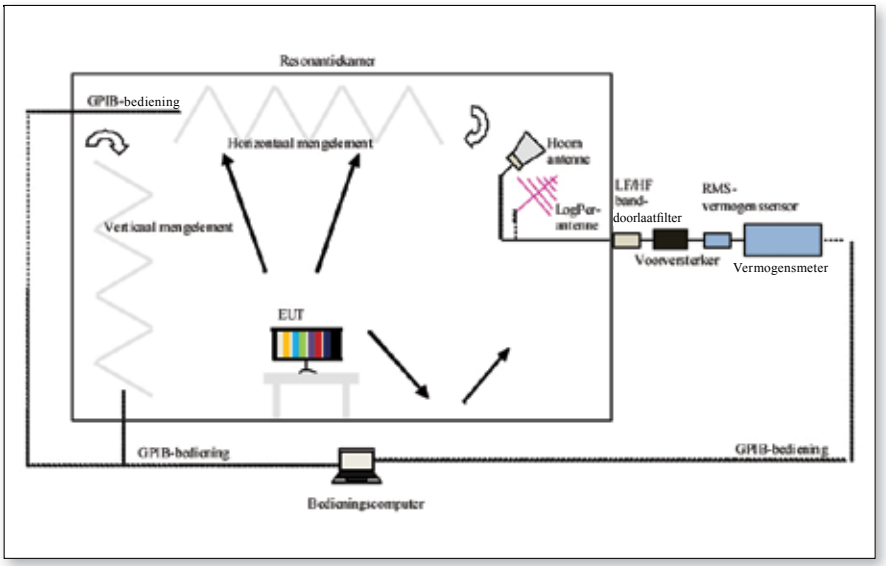
Deze publicatie beschrijft de meetmethode die ontwikkeld is om het maximale totale uitgestraalde vermogen te meten met behulp van de Resonantiekamer (Rk). Er wordt zowel een beschrijving van de kalibratie van de kamer gegeven als van de verificatie van de meetmethode. Tenslotte worden er enige meetresultaten van daadwerkelijke multimediaproducten gegeven.

II. DE RESONANTIEKAMER ALS HULPMIDDEL BIJ HET METEN VAN HET TOTALE UITGESTRAALDE VERMOGEN

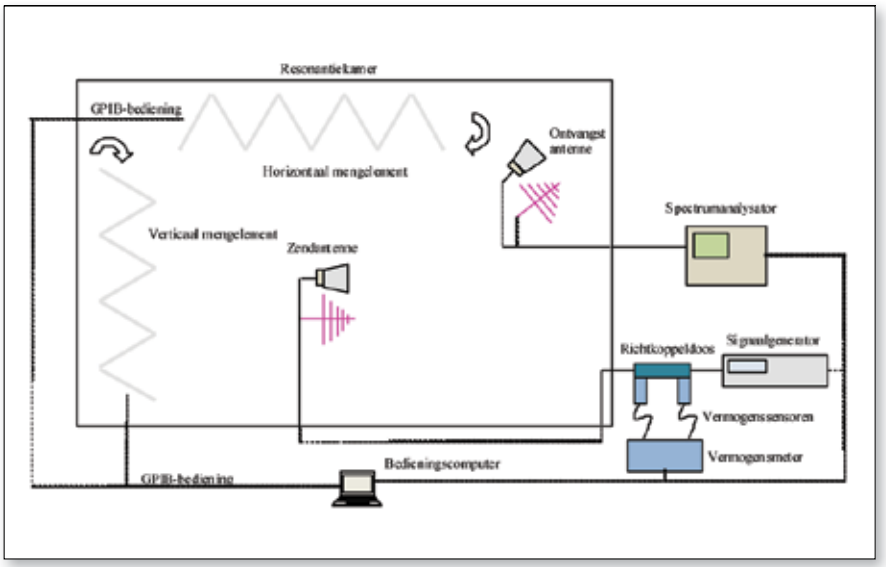
De Resonantiekamer is een bekend hulpmiddel om het totale uitgestraalde vermogen (TRP) van intentionele ze-



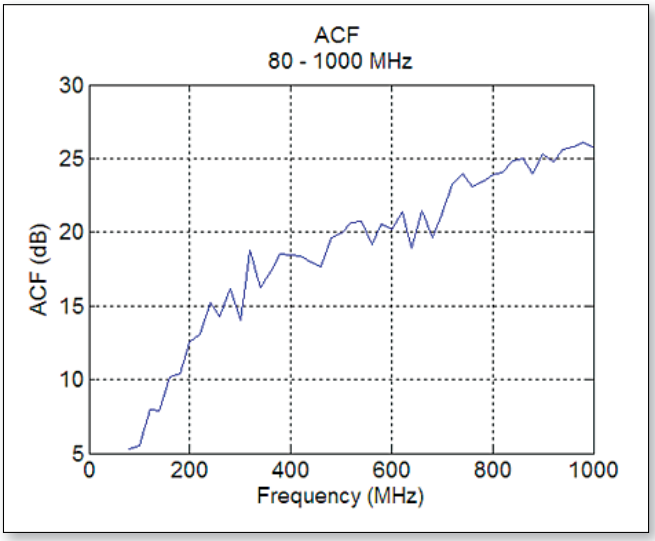
AFB. 1: Overzicht typen EMV-blootstellingslimieten.



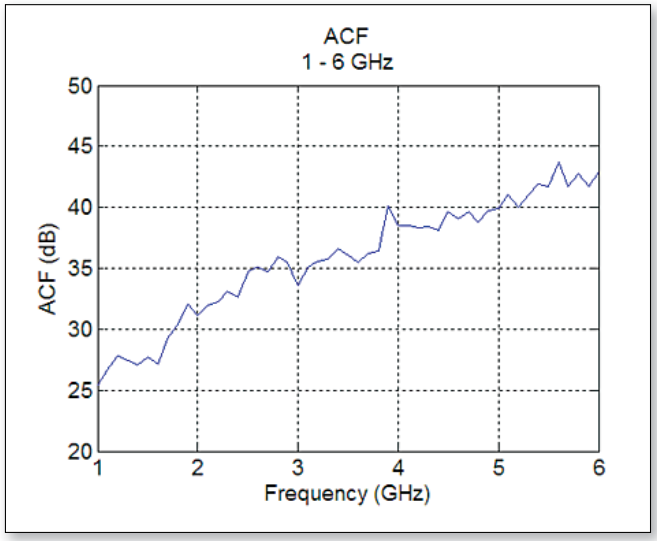
AFB. 2: Opstelling TRP-meting resonantiekamer.



AFB. 3: Opstelling kalibratie resonantiekamer.



AFB. 4: Antennekalibratiefactor (ACF) 80 – 1000 MHz.



AFB. 5: Antennekalibratiefactor (ACF) 1 – 6 GHz.

nders snel te kunnen meten [5]. De Rk wordt daarom door de auteurs bij de bewerking van ECMA TR/97 [2] naar voren geschoven als testfaciliteit om bij de TRP-meetmethode te gebruiken. In principe wordt de TRP van een EUT bepaald door een EUT in een Rk te plaatsen en het uitgangsvermogen van de Rk te meten met een rms-vermogenssensor (zie Afb. 2). Meten van de TRP met een Rk voor EMV-toetsing is om de volgende redenen zeer gunstig:

- de meetmethode tast de apparatuur niet aan,
- de TRP wordt gemeten als rms-vermogen, wat dezelfde meetgegevens oplevert als vereist voor het laagvermogen drempelniveau van 20 mW,
- de TRP van meerdere zenders en/of breedbandzenders kan ineens worden gemeten,
- het bruikbare frequentiebereik van een Rk beslaat de frequentiebereiken die algemeen gebruikt worden voor radio- en communicatiezenders.

Wij wijzen erop dat de testmethode die hier wordt beschreven, alleen EMV-naleving bepaalt van een EUT in een specifiek frequentiebereik, namelijk 80 MHz – 6 GHz, aangezien dit het praktisch bruikbare frequentiebereik is van de gebruikte Rk en de bijbehorende meetapparatuur. In de praktijk kan het bovenste frequentiebereik voor TRP-metingen in een Rk veel hoger uitvallen en hangt dit af van de frequentiebeperkingen van de vereiste meetapparatuur. De TRP wordt gemeten gedurende een periode van 6 minuten, wat de gemiddelde tijd is voor tijdvariabele signalen voor specifieke absorptieratio (SAR) waarden (10 MHz – 10 GHz).

III. KALIBRATIE RESONANTIEKAMER

Voordat TRP-metingen kunnen worden uitgevoerd op een daadwerkelijke EUT, moet de Rk gekalibreerd worden om de verliezen die inherent zijn aan de kamer te kunnen bepalen. In IEC 61000-4-21 [6] worden gedetailleerde beschrijvingen gegeven voor Rk-kalibratie en testmethoden voor zowel emissie als immuniteit. De kalibratiemethode beschreven in de norm is zeer uitgebreid en bepaalt verschillende factoren:

- antenne-kalibratiefactor (ACF; Antenna Calibration Factor) – vertegenwoordigt het verlies van de kamer gebaseerd op het gemeten gemiddelde vermogen
- IL (Insertion Loss) – vertegenwoordigt het verlies van de kamer gebaseerd op het gemeten maximale vermogen
- velduniformiteitsfactoren in x-, y- en z-richting – vertegenwoordigen de kwaliteit van de uniformiteit van het veld in de kamer binnen het werkingsvolume

Al deze factoren worden bepaald voor negen locaties in de kamer, die de grenzen van het werkingsvolume aangeven. De mengelementen van de Rk worden gebruikt in de gestapte stand.

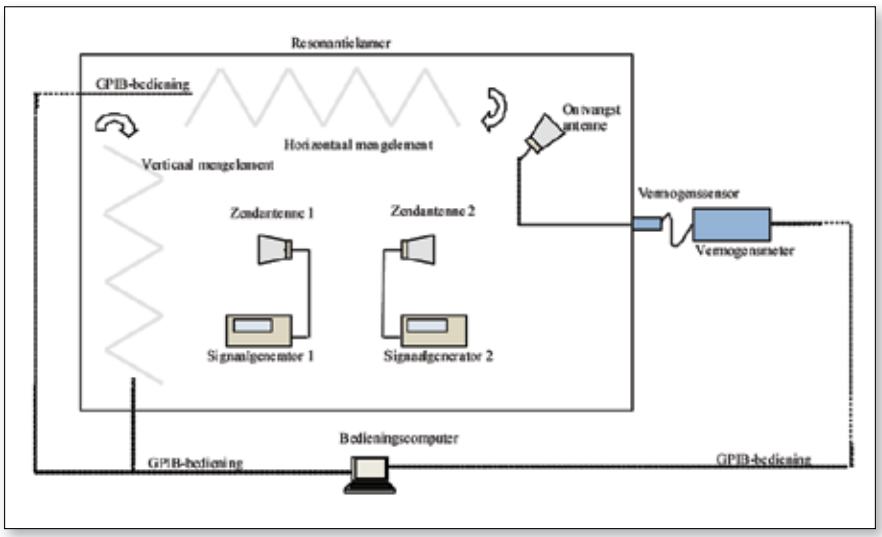
Voor TRP-metingen is besloten een klein deel van het complete kalibratieproces dat nodig is voor correcte TRP-metingen uit te voeren:

- alleen de ACF wordt bepaald, aangezien het gemeten gemiddelde vermogen vereist is voor de 20 mW regel
- de ACF wordt op slechts één locatie bepaald, namelijk in het midden van het werkingsvolume, wat vergelijkbaar is met de daadwerkelijk toegepaste opstelling
- vermogensmetingen worden uitgevoerd in het frequentiebereik 80 MHz – 6 GHz, wat het werkbare frequentiebereik is van de Rk in combinatie met de gebruikte apparatuur
- per frequentiepunt worden doorlopende vermogensmetingen uitgevoerd gedurende een periode van 6 minuten; 6 minuten is de gemiddelde tijd voor SAR in het frequentiebereik 10 MHz – 10 GHz (zie [2])

Het doel van de kalibratie is om de energieoverdracht tussen de zendantenne en de ontvangstantenne te bepalen. Dit geeft een indicatie van de inherente verliezen in deze Rk.

In Afb. 3 wordt een blokdiagram van de opstelling voor de Rk-kalibratietest weergegeven. De Rk heeft twee mengelementen (horizontaal en verticaal) die beide zijn ingesteld op een doorlopende mengstand, met verschillende snelheden voor beide, zodat er geen herhaling van de gecombineerde standen voorkomt in de kamer. Er werden twee typen antenne gebruikt op basis van hun effectiviteit in bepaalde frequentiebereiken, namelijk een log-periodische antenne voor het frequentiebereik 80 – 1000 MHz en een hoornantenne voor het bereik 1 – 6 GHz. De zendantenne wordt in het midden van het werkingsvolume van de kamer

geplaatst op een hoogte van 1 m boven de vloer. Deze positie van de zendantenne is zo gekozen dat hiermee de locatie van een EUT bij daadwerkelijke TRP-metingen wordt nagebootst. Met behulp van de signaalgenerator en de zendantenne wordt een bekend vermogensniveau in de Rk ingebracht. De richtkoppeldoos en de vermogensmeter worden gebruikt om de voorwaartse en gereflecteerde vermogens te bepalen zodat rekening gehouden wordt met verliezen vanwege misaanpassing. Per frequentiepunt wordt het gemiddelde vermogen gemeten met de ontvangst-antenne en een spectrumanalysator gedurende een periode van 6 minuten.



AFB. 6: Opstelling verificatie resonantiekamer voor TRP.

Voor correcte TRP-metingen is het nodig om het gemiddelde vermogen te bepalen zodat dit kan worden vergeleken met het laagvermogencriterium van 20 mW. Het doel van de kalibratie is dus om de gemiddelde energieoverdracht tussen de zendantenne en de ontvangstantenne te bepalen. Deze overdrachtsfactor wordt de antennekalibratiefactor (ACF) genoemd en kan worden gezien als een verliesfactor van de kamer. Tijdens TRP-metingen op een daadwerkelijk MM-product moet het ontvangen gemiddelde vermogen (Pavg) gecorrigeerd worden met de ACF-waarde voor de gemeten frequentie om het daadwerkelijke TRP te verkrijgen die door de EUT wordt uitgestraald (1).

1) $TRP\ (dBm) = P_{avg}\ (dBm) + ACF\ (dB)$

Afb. 4 en Afb. 5 tonen de ACF van de Rk in de frequentiebereiken 80 – 1000 MHz en 1 – 6 GHz.

IV. VERIFICATIE TRP-MEETMETHODE

Om meer vertrouwen te krijgen in de resultaten die verkregen werden met de TRP-meetmethode, werd besloten om de methode te verifiëren door een aantal kunstmatige EUT's met bekende en afstembare uitstralingseigenschappen te meten. De toepassing van gesynthetiseerde en meervoudige intentionele zenders biedt de mogelijkheid om de som van vermogens van meervoudige breedband intentionele signalen in de Rk te bestuderen en te verifiëren.

Verificatiemetingen zijn uitgevoerd met onafhankelijke intentionele zenders die werden gerealiseerd met behulp van een set bestaande uit twee hoornantennes en signaalgeneratoren. Het daadwerkelijk ingebrachte vermogen via de ingangsaansluiting van de hoornantenne werd van tevoren gemeten en benoemd als het daadwerkelijke TRP (TRPactual). In Afb. 6 wordt de opstelling van de meting weergegeven. Het gemiddelde ontvangen vermogen (Pavg) wordt gemeten met behulp van een ontvangsthoornantenne en een breedband vermogensmeter. Na het corrigeren van het gemeten gemiddeld ontvangen vermogen met de juiste ACF-factor, kan het geschatte TRP (TRPestimated) worden berekend (2).

2) $TRP_{estimated}\ (dBm) = P_{avg}\ (dBm) + ACF\ (dB)$

3) $TRP_{estimated}\ (dBm) - TRP_{actual}\ (dBm) = \Delta$

Het verschil tussen het geschatte TRP en het daadwerkelijke TRP geeft een indicatie van de precisie waarmee TRP-metingen kunnen worden uitgevoerd in de Rk (3). Het ruisniveau van de Rk werd bepaald door een TRP-meting uit te voeren in een lege kamer. De gemeten waarde voor Pavg was -52 dBm. Door deze waarde te corrigeren voor een ACF in het slechtste geval (44 dB bij 5,5 GHz, Afb. 5, Tabel III) krijgen we een conservatieve minimum TRP-waarde die kan worden gemeten in deze Rk van 0,16 mW (-52 dBm + 44 dB = -8 dBm = 0,16 mW). Door een voorversterker te gebruiken kon dit ruisniveau verder worden verlaagd tot 1 µW, wat nodig was om het TRP te kunnen meten van niet-intentionele zenders (Afb. 5, Tabel 4).

Er zijn meerdere verificatiemetingen uitgevoerd waarin verschillende combinaties van factoren zoals frequentie, modulatie, aantal bronnen en de plaatsing van de bron werden gevarieerd om een optimale dataset te kunnen verkrijgen (Tabel 1). Elke meting is 3 keer uitgevoerd om een idee te krijgen van de herhaalbaarheid van de meetmethode.

Bij een enkelvoudige bron kan het geschatte TRP worden gevonden door de ACF op een bepaalde frequentie op te tellen bij het gemeten ontvangen vermogen. Bij meervoudige onafhankelijke bronnen wordt het TRP verkregen door de TRP van de individuele bronnen bij elkaar op te tellen [7]. Dus om het TRP van meervoudige bronnen op verschillende frequenties in de Rk te meten, wordt het geschatte TRP bepaald door de ACF voor het slechtste geval in het frequentiebereik dat alle bronnen omvat, op te tellen bij het gemeten ontvangen vermogen. Omdat de ACF voor het slechtste geval wordt gebruikt, is het geschatte TRP in feite een zeer conservatieve waarde.

Bij meerdere bronnen op dezelfde frequentie kan het geschatte TRP worden bepaald door weer eenvoudig de ACF bij de juiste frequentie op te tellen bij het gemeten ontvangen vermogen.

Wanneer de bronnen gemoduleerd zijn, moet de correcte kamerkalibratiefactor (ACF) zorgvuldig worden bepaald afhankelijk van de frequenties die bestreken worden door

de spectrale componenten van de gemoduleerde signalen.

In termen van precisie kan worden gesteld dat voor een enkele bron het TRP kan worden bepaald met een precisie van ongeveer 2 dB (Δ). Bij meervoudige bronnen op verschillende frequenties kan het TRP worden bepaald met een precisie van 3 dB (Δ). Men mag niet vergeten dat er in dit geval een conservatieve TRP-waarde wordt bepaald, aangezien de ACF voor het slechtste geval wordt gebruikt als correctie. Bij meervoudige bronnen op één frequentie kan het TRP worden bepaald met een precisie van minder dan 0,5 dB (Δ).

Tabel 2 toont de meetresultaten van één van de verificatiemetingen (meervoudige bronnen op één frequentie: 2,4 GHz, CW); zie Afb. 7. Er is te zien dat er een goede correlatie bestaat tussen de daadwerkelijke en de geschatte TRP-waarden (Δ < 0,5 dB).

Over het geheel genomen kan worden geconcludeerd dat er een goede correlatie bestaat tussen het gemeten ontvangen vermogen en het berekende ontvangen vermogen dat verkregen wordt door de individuele vermogenscomponenten eenvoudigweg bij elkaar op te tellen. Dit impliceert dat alle vermogensbronnen in de Rk als niet-gecorreleerd kunnen worden behandeld; hetgeen een bekende intrinsieke eigenschap van de Rk is. Verdere details kunt u vinden in [9].

Freq. (GHz)	MODULATIE	AANTAL BRONNEN	POSITIE VAN BRONNEN
1,8	Doorlopende golf (DG)	Enkel	Bronnen gericht in verschillende richtingen
2,4	Amplitudemodulatie (AM) 1kHz, 80%	Meervoudig	
	Frequentiemodulatie (FM) 1 kHz, 10 MHz deviatie		Bronnen gericht in dezelfde richting
	Pulsmodulatie (PM) 577 µs, 217 Hz		

TABLE 1: VERIFICATIEMETINGEN - INVLOED HOEVEELHEDEN BRON(NEN).

Freq. (GHz)	ACF (dB)	Uitgangsvermogen generator[a] (dBm)	Uitgangsvermogen splitter (dBm)	Daadwerkelijk TRP[b] (dBm)	Mod.
2,4	32,621	0	-6 dBm naar hoorn 1 + -6 dBm naar hoorn 2	-7,6 + -7,2 = -4,385	CW

Nr.	Gemeten ontvangen vermogen (dBm)	Geschatte TRP[c] (dBm)	Δ[d] (dB)
1.	-36,916	-4,295	0,090
2.	-36,587	-3,966	0,419
3.	-36,647	-4,026	0,359

TABLE 2: VOORBEELD VERIFICATIEMETING (MEERVOUDIGE BRONNEN OP 2,4 GHz, DOORLOPENDE GOLF).

[a] het uitgangsniveau van de generator is het CW-niveau dat wordt aangegeven op het display van de generator
[b] daadwerkelijk vermogen aan de ingangsaansluiting van de antenne
[c] d.w.z. gemeten ontvangen vermogen + ACF
[d] geschat TRP – daadwerkelijk TRP

V. TRP-METINGEN OP MM-PRODUCTEN

Het blokdiagram voor de TRP-metingen wordt gegeven in Afb. 2. Het MM-product wordt midden in het werkingsvolume van de Rk geplaatst (Afb. 8). Metingen worden uitgevoerd in twee frequentiebereiken, namelijk 80 – 1000 MHz en 1 – 6 GHz. Er wordt een aanvullende voorversterker toegepast om voldoende dynamisch bereik te verkrijgen omdat de vermogensniveaus die door MM-producten worden uitgestraald, erg laag zijn.

In het algemeen kunnen producten zowel diverse bronnen van emissie (niet-intentionele zenders) als één of meer draadloze technologieën (intentionele zenders) bevatten. Vermogensmetingen worden gedaan over een compleet frequentiebereik in tegenstelling tot een bepaalde vaste frequentie (zoals het geval was bij de verificatiemetingen), wat betekent dat er een breedbandmeting wordt uitgevoerd. Daarom moet per frequentiebereik de ACF in het slechtste geval genomen worden als de toe te passen correctiefactor (Afb. 4, Afb. 5 en Tabel 3). Dit levert een schatting voor het slechtste geval op van de daadwerkelijke TRP-waarde.

Er werden hoofdzakelijk TRP-metingen uitgevoerd op een aantal MM-producten die geclassificeerd worden als niet-intentionele zenders, d.w.z. producten die geen antenne bevatten om opzettelijk RF-vermogen uit te zenden (bijv. televisietoestel, monitor, dvd-speler, digitale audiospeler enz.). De verkregen resultaten werden geanalyseerd en vergeleken met de TRP-limiet van 20 mW (Tabel 4). Er werd vastgesteld dat een typisch TRP-niveau voor deze niet-intentioneel uitstralende MM-producten in de ordegrootte ligt van enkele tientallen µW en daarmee dus veel lager ligt dan de laagvermogenlimiet van 20 mW [8].

Daarnaast werden er TRP-metingen uitgevoerd op MM-producten met één of meer intentionele zenders (bijv. draadloze hoofdtelefoon, RF4CE-afstandsbediening) [10]. Om deze apparatuur naar behoren te doen functioneren, was er randapparatuur nodig om de draadloze verbinding tot stand te kunnen brengen. Het maximaal gemeten TRP-niveau van de intentionele zenders waarbij een Bluetooth-verbinding tot stand werd gebracht, was in de ordegrootte van 100 – 150 µW. Dit is veel lager dan zowel het maximaal toegestane vermogen van 2,5 mW (Bluetooth 10 m, klasse 2) als de TRP-limiet van 20 mW (Tabel 4). Voor de RF4CE-afstandsbediening werd een TRP-waarde gemeten van 1,3 mW, wat alweer veel lager is dan zowel het maximaal toegestane vermogen van 100 mW (Zigbee RF4CE) als de TRP-limiet van 20 mW. Het is voor zowel Bluetooth als RF4CE

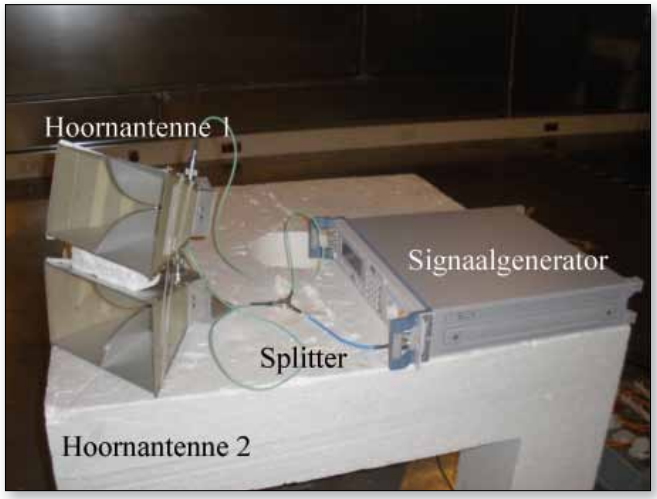
bekend dat het uitgezonden vermogen wordt teruggebracht nadat de draadloze verbinding tot stand is gebracht.

VI. CONCLUSIES

Het laagvermogencriterium van 20 mW kan worden gebruikt als een limiet voor het demonstreren van EMV-naleving voor MM-producten. De Rk bewijst een nuttig hulpmiddel te zijn bij het bepalen van TRP-waarden voor MM-producten. Na het uitvoeren van een relatief snelle kalibratie kan de Rk worden gebruikt om TRP-waarden te meten gedurende een periode van 6 minuten. Verificatiemetingen met bekende bronnen laten zien dat de methode goed herhaalbaar is. Er wordt ook een goede correlatie gevonden tussen de daadwerkelijke en de geschatte TRP-waarden, voor zowel enkele als meervoudige bronnen. Metingen uitgevoerd op daadwerkelijke MM-producten laten zien dat de TRP-waarden ver onder de 20 mW limiet blijven, voor zowel niet-intentionele als intentionele zenders.

REFERENTIES

- [1] IEC 62311 – Internationale norm – Beoordeling van elektrische en elektronische apparatuur blootgesteld aan het menselijk lichaam aan elektromagnetische velden (0 Hz – 300 GHz), uitgave 1, 2007-08.
- [2] ECMA Internationaal technisch rapport – TR/97 – Gids voor de toetsing van blootstelling van mensen aan elektromagnetische velden van multimediaproducten overeenkomstig IEC/EN 62311, 1e uitgave, juni 2009.
- [3] ICNIRP-richtlijnen voor het beperken van blootstelling aan tijd-variabele elektrische, magnetische en elektromagnetische velden (tot maximaal 300 GHz) – International Commission on Non-Ionizing Radiation Protection, gepubliceerd in Health Physics 74(4): 494-522; 1998.
- [4] IEC 62479 – Internationale norm – Beoordeling van de bestendigheid van laag vermogen elektronische en elektrische apparatuur met de standaard beperkingen in verband met blootstelling van het menselijk lichaam aan elektromagnetische velden (10 MHz – 300 GHz), uitgave 1, 2010-06.
- [5] S. Depienne et al, De resonantiekamer: een nuttig hulpmiddel voor het karakteriseren van het uitgestraalde vermogen van kleine RF-apparaten, IEEE-conferentiepublicaties 2003, bladzijde(n) 461-464.
- [6] IEC 61000-4-21 – Internationale norm – Beproevingen en meettechnieken - Beproevingsmethode voor nagalmkamers, uitgave 2, 2011-01.
- [7] IEC/TR 62630 – Technisch rapport – Leidraad voor het beoordelen van blootstelling aan meervoudige elektromagnetische bronnen, uitgave 1, 2010-03.
- [8] ECMA witboek ECMA/TC20/2009/019, Meetresultaten totaal uitgestraald vermogen van multimediaproducten in resonantiekamer; Niet-intentionele zenders, versie 3, 2009-04-06.
- [9] Philips EMC Center rapport – Metingen totaal uitgestraald vermogen resonantiekamer; Verificatie van TRP-metingen van meervoudige intentionele zenders – EMC-09-KB-005-RRP, Konika Banerjee, 2009-06-16.
- [10] Philips EMC Center rapport – Meetresultaten totaal uitgestraald vermogen van multimediaproducten in resonantiekamer – Deel 2; Intentionele en niet-intentionele zenders – EMC-09-KB-012-RRP, Konika Banerjee, 2009



AFB. 7: Afbeelding van verificatiemeting in Rk met meervoudige bronnen op één enkele frequentie gericht in dezelfde richting

Frequentiebereik	Max. ACF
80 - 1000 MHz	26 dB
1 - 6 GHz	44 dB

TABLE 3: MAXIMUMWAARDE VAN ACF PER FREQUENTIEBEREIK.

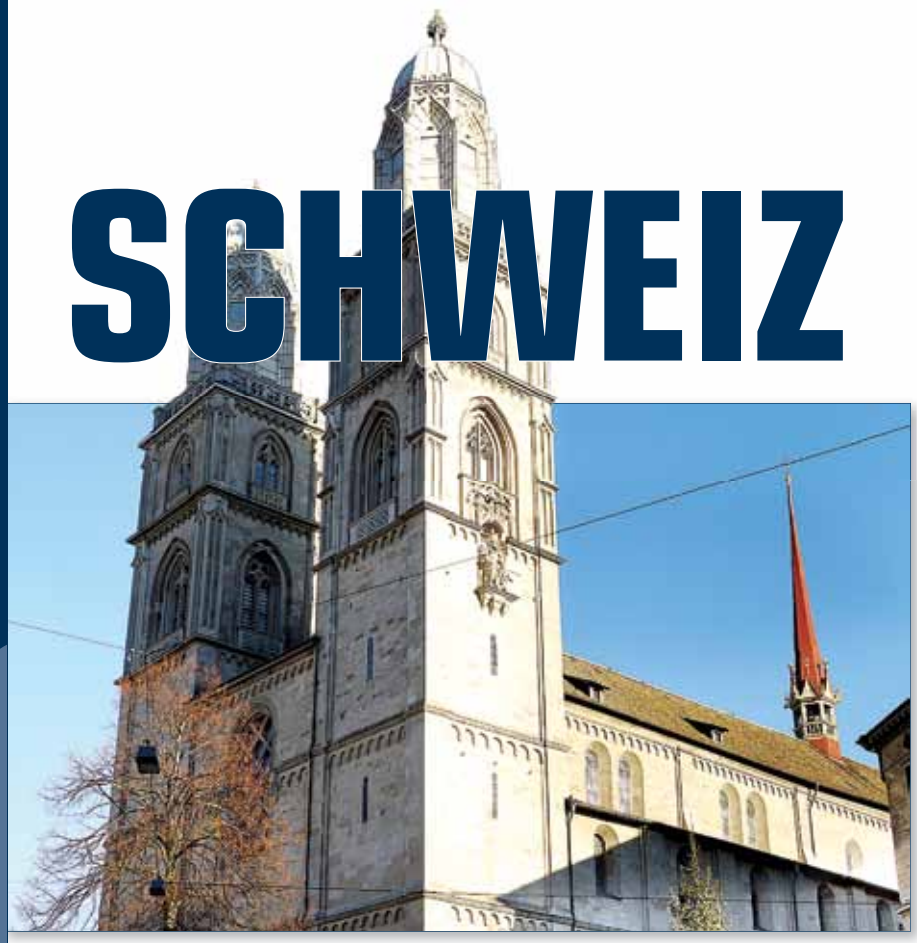
Nr.	MM - product	TRP (80 MHz - 6 GHz) µW
Niet - intentionele zenders		
1	22 inch tv - toestel	37
2	32 inch tv - toestel	47
3	42 inch tv - toestel	23
4	22 inch tv - toestel	30
5	Dvd - speler	10
6	Luidsprekerset	15
Intentionele zenders (@ 2,4 GHz)		
7	Digitale audiospeler (Bluetooth)	124
8	Draadloze Hoofdtelefoon (Bluetooth)	100
9	Afstandsbediening (RF4CE)	1300

TABLE 4: TRP - MEETRESULTATEN VAN MM - PRODUCTEN.



AFB. 8: Afbeelding van TRP-meting van multimediaproduct (tv-toestel) in Rk

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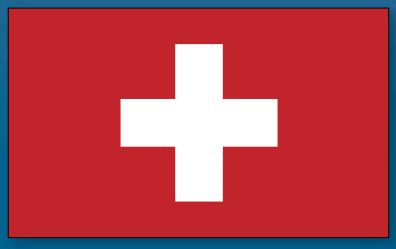


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EMV Filter Auslegung und Optimierung

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EIN PRAXISORIENTIERTER ANSATZ

SCHALTNETZTEILE WERDEN in nahezu allen elektronischen Geräten eingesetzt. Die Anforderung an solche Geräte ist sehr hoch. Die Effizienz steht immer mehr im Zentrum und sollte so hoch wie möglich sein. Vermehrt werden resonanzschaltende Technologien eingesetzt. Die Geräte müssen immer kompakter werden. Vielfach wird dies durch höhere Schaltfrequenzen erreicht, da sich dabei die magnetischen Komponenten kleiner auslegen lassen. Die Schal-tungsdichte wird immer grösser. Höhere Schaltfrequenzen und höhere Schaltungsdichten können die Emissionen von einem Gerät stark verschlechtern.

Das Produkt sollte so günstig wie möglich sein. „Time to market“ ist für Neuentwicklungen enorm wichtig. Ein früher Markteintritt ist für den Erfolg von einem Produkt vielfach aus-schlaggebend. Ein Produkt kann erst auf den Markt kommen, wen es die gesetzlichen Nor-men erfüllt.

Oftmals ist das EMV Filter ein entscheidendes Glied für eine optimale Lösung. Die richtige EMV Filter Topologie von Beginn an kann während der Zertifizierung und Optimierung des Produkts viel Zeit sparen. Zusätzliche Entwicklungs-Loops können entfallen. Ein richtig di-mensioniertes EMV Filter reduziert auch die Gerätekosten.

Der folgende Fachbericht verschafft Ihnen Einblicke in die Entwicklung von EMV Filtern. Der Fachbericht zeigt, wie wichtig es ist alle parasitären Effekte der Filterelemente zu berücksich-tigen und wie eine praxisnahe Simulation den Entwicklungsprozess beschleunigt.

Der Erfolg eines Produktes besteht oft darin, wie schnell es am Markt erhältlich ist. Die Zertifizierung ist ein zeitintensiver Aufwand. Ein negatives Resultat während der Zertifizierung könnte schwerwie-gende Folgen haben. Das Resultat könnte ein Redesign sein, die Entwicklungskosten werden erhöht. Die Markteinführung verspätet sich, was zu weiteren Kosten führt.

Die Emissionen von Schaltnetzteilen können in zwei Kategorien aufgeteilt werden. Den leitungsge-bundenen Störungen und den Störungen die abgestrahlt werden. Die leitungsgebundenen Störungen werden im Frequenzbereich von einigen kHz bis 30MHz gemessen. Die

abgestrahlten Störungen werden ab 30MHz bis zu einigen GHz gemessen. Um die leitungsgebundenen Störungen zu dämp-fen, werden LC-Filter eingesetzt. Das EMV Netzt Filter in einem Netzteil ist ein grosser Bestandteil vom Netzgerät. Gross aus zweierlei Hinsicht. Es braucht viel Platz, es kann nicht beliebig angeordnet werden. Die Kosten von den verwendeten Drosseln bei höheren Eingangsströmen können sehr hoch sein.

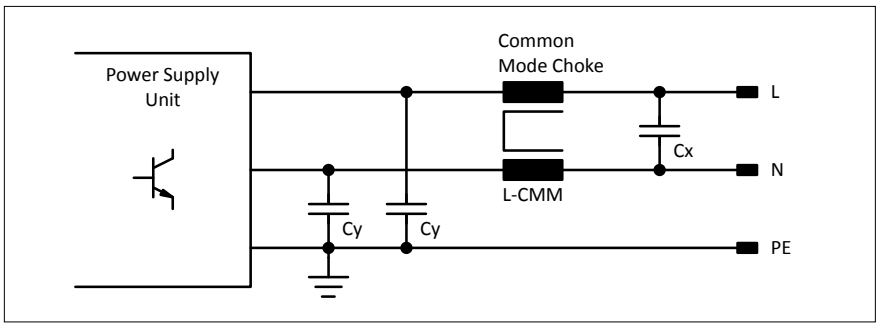


Bild 1: LC Filter

Ein vielfach normaler Zustand ist der hohe Zeitdruck das Produkt so schnell als möglich zu entwickeln. Aufgrund der fehlenden Zeit, wir oft nicht das optimalste Filter entwickelt.

Das Resultat kann ein überdimensioniertes Filter sein, welches unnötige Kosten verursacht. Die Mate-rialkosten vom EMV-Filtern können schnell einmal 15% von den Gesamtkosten bei einem Schaltnetz-teil ausmachen. Vielfach wird das EMV Filters nach der „cut and try" Methode entwickelt und optimiert. „Cut and Try" meint in diesem Fall es werden Filterelementen wie Induktivitäten und Kapazitäten im-mer wieder ausgetauscht. Man lötet die neuen Bauteile zusammen bis die gemessenen Störungen unterdrückt werden. Oft kann man bei diesem Vorgehen den Einfluss der Änderungen nicht nachvoll-ziehen. Am Ende hat man eine Lösung, doch ist diese Lösung auch die beste?

STÖRUNGSARTEN: GLEICHTAKT (COMMON MODE) ODER GEGENTAKT (DIFFERENTIAL MODE) STÖRUNG

Für das Design von einem optimalen EMV Filter, ist es wichtig die Störungsart zu kennen. Ebenfalls wichtig zu wissen, in welchem Frequenzberiech die Störung dominant auftaucht. Bei leitungsgebun-denen Störungen können wir zwischen Gegen- (DM) und Gleichtaktstörungen (CM) unterscheiden. DM Störungen treten dominant im tiefen Frequenzbereich bis 1 MHz auf. Die Störquelle für differenti-elle Störungen in Netzteilen ist meistens der Zwischenkreis-Kondensator im DC Bus. Der Ripple-Strom (z.B. von einer aktiven PFC) erzeugt über dem ESR des Kondensators einen Spannungsabfall. Es ist genau dieser Spannungsabfalle den wir als DM Störung messen. Gleichtaktstörungen tauchen zwischen 1MHz bis über einigen hundert Megahertz auf. In diesem Frequenzbereich müssen die pa-rasitären Effekte und Koppelpfade mit betrachtet werden. Ist uns die Störungsart sowie der Koppel-pfad bekannt, kann mit dem EMV Filter design gestartet werden.

KAPAZITIVE DROSSELN UND INDUKTIVE KONDENSATOREN

Die meist benutzte Filterstruktur für ein EMV Filter ist die LC Topologie. Das LC Filter besteht vielfach aus einer Common Mode Drossel, zwei Y-Kondensatoren und einem X-Kondensator. Die Streuinduk-tivität der Common Mode Drossel wird zusammen mit dem X-Kondensator genutzt um die differentiel-len Störungen zu unterdrücken. Die richtige Wahl der Induktivität spielt dabei eine wichtige Rolle. Ein maßgebender Punkt ist die Betrachtung des Frequenzverhaltens der Filter Elemente. In den folgen-den Abschnitten werden wir die parasitären Effekte und deren Einfluss anhand von einem LC Filter untersuchen. Bild 1: zeigt die verwendete Filtertopologie.

Die Kondensatoren Cy sind die Y-Kondensatoren. Diese Kondensatoren formen Pfade mit tiefer Im-pedanz, die die Störung zurück zur Quelle führen (dem Schalttransistor des Netzteils). Die Drossel L-CMM bildet den hochohmigen Pfad für die Common Mode Ströme. Der Kondensator Cx zusammen mit der Streuinduktivität der Common Mode Drossel unterdrückt die differentiellen Störungen.

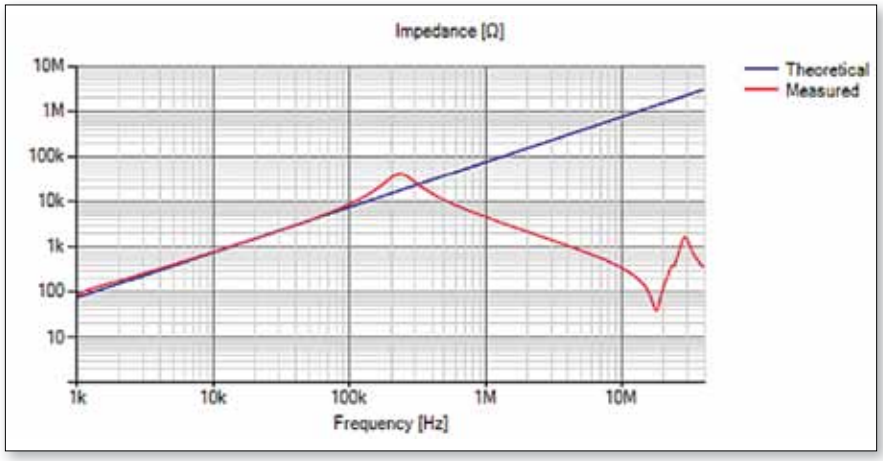


Bild 2: 10mH CMM Induktivität

In Bild 2 können wir die Impedanz einer 10mH Common Mode Drossel sehen. Die blaue Linie zeigt das ideale Verhalten einer 10mH Drossel, die rote Linie zeigt den gemessenen Wert. Die Resonanz-frequenz der Induktivität liegt bei 200 kHz. Oberhalb dieser verhält sich die Drossel kapazitiv. Die Re-sonanz bei ca. 20MHz ist auf die Streuinduktivität zurückzuführen. Common Mode Störungen sind typischerweise über 1MHz dominant. Somit wird schnell klar, die Betrachtung der Drossel als ein „Ide-ales" Bauelement, ist ungenügend.

Nun werden wir das Frequenzverhalten von einem Y-Kondensator

genauer analysieren. Bild 3 zeigt die gemessene (Rot) und die theoretische (Blau) Impedanz für einen 2.2nF Y-Keramikscheibenkondensator. Der Kondensator hat ein sehr gutes Frequenzverhalten. Dies ist auf die sehr tiefe Eigen-Induktivität der Keramikscheibe zurückzuführen. Die Resonanzfrequenz ist über 30 MHz. Dank diesem Verhalten, kann der Kondensator benutzt werden um leitungsgebundene Common Mode Störungen effektiv zu reduzieren.

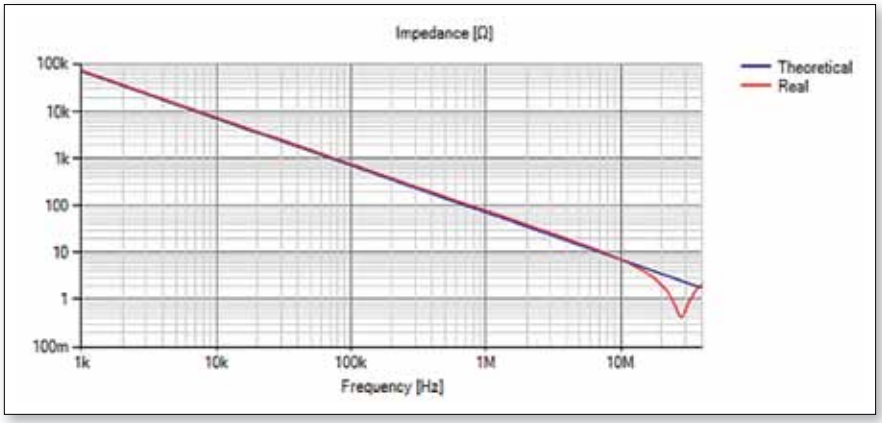


Bild 3: 2n2 Y2 Kondensator

Das reale Verhalten von passiven Bauelementen für EMV Filter ist bei weitem nicht optimal. Um eine Aussage über die Dämpfungseigenschaft von einem EMV Filter zu machen müssen wir das Frequenzverhalten der Filterelemente berücksichtigen.

EMV FILTER AUSLEGUNG, BASIEREND AUF GEMESSENEN WERTEN

Um ein EMV Filter auszulegen schreiten wir normalerweise wie folgt voran: Wir messen das Stör-spektrum. Wir versuchen das Störspektrum in die Common Mode und die differentiellen Störanteile zu unterteilen. Wen wir den Spitzenwert der Störung und die Grenzwerte kennen, kann die benötigte Dämpfung berechnet werden. Die Berechnung der notwendigen Dämpfung kann auf verschiedene Weisen erfolgen.

Eine Möglichkeit, die Berechnung basierend auf den theoretischen Werten der Induktivität und der Kapazität. Wie wir bereits gesehen haben, ist dies nicht der beste



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Weg, die parasitären der Filterelemente bleiben unberücksichtigt. Eine andere Möglichkeit ist die Nutzung von einem Spice Simulator. Für eine aussagkräftige Lösung müssen die Ersatzschaltbilder von jedem einzelnen Element vorlie-gen, welche alle parasitären Elemente beinhalten. Das herleiten der Ersatzschaltbilder kann ja nach Genauigkeit und Anzahl der Bauteile ein zeitintensive Prozedur sein.

Eine weitere Möglichkeit ist die Filter Simulation basierend auf den gemessenen Impedanzen der Filterelemente. In Bild 2 und 3 sehen wir die gemessene Impedanz. Alle parasitären Effekte der Fil-terelemente werden mitberücksichtigt. Wen wir direkt mit den gemessenen Impedanzen eine Simulati-on durchführen könnten, würden wir ein sehr genaues Ergebnis erhalten.

Was brauchen wir für diese Art von Simulation?

Sind wir nicht im Besitz aller Impedanz-Kurven, benötigen wir einen Vektor Netzwerk Analyzer (VNA) um die Impedanz und den Phasenverlauf von Filterelementen über den gewünschten Frequenzbereich zu messen. Für die Simulation die in diesem Bericht gezeigt wird, wurde ein VNA mit einem ex-ternen Impedanz Adapter verwendet. Mit dem externen Impedanz Adapter können schnelle und ge-naue Messungen durchgeführt werden. Bild 4 zeigt den Testaufbau.

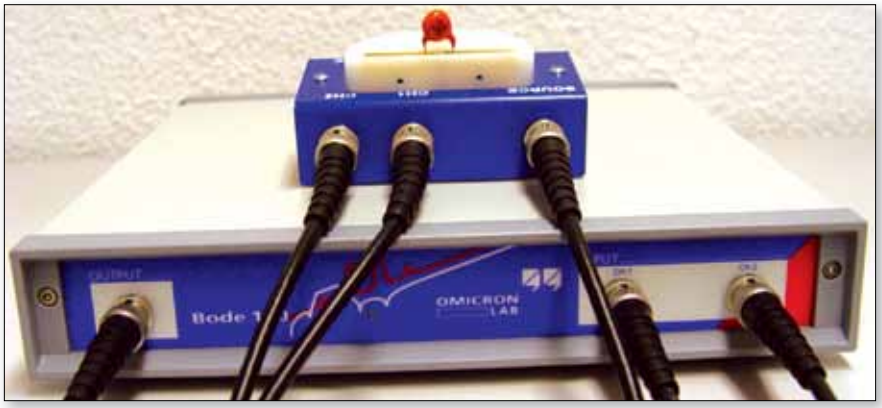


Bild 4: VNA mit Impedanz Adapter

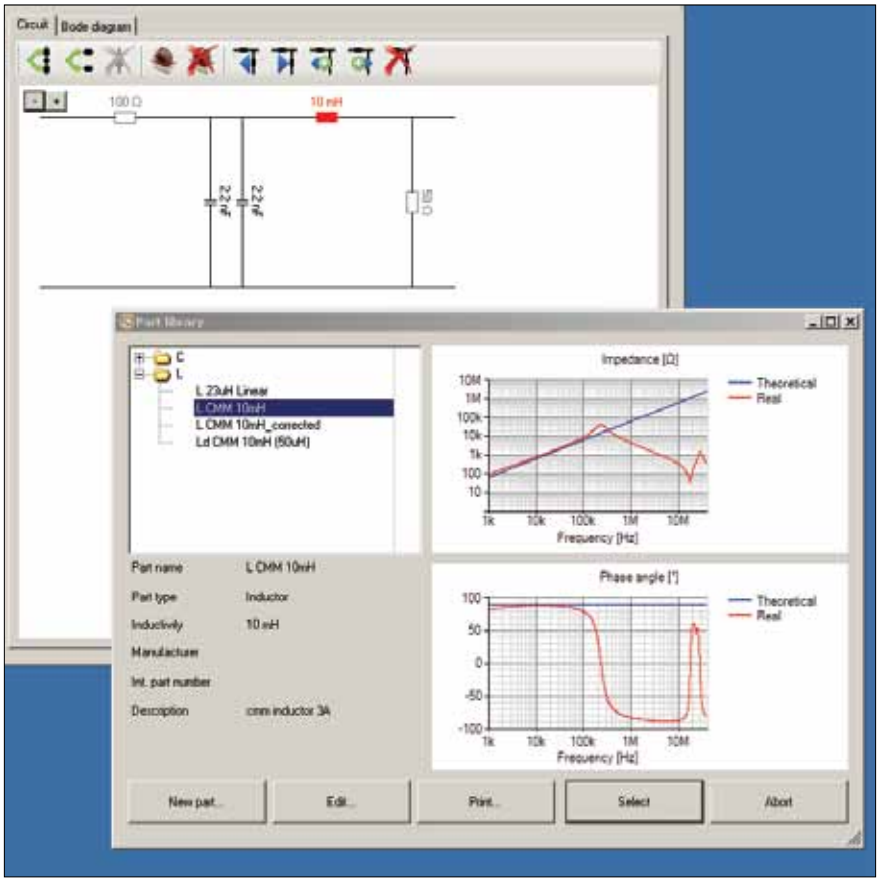


Bild 5: EFsyn Filter Software

Wen wir alle benötigten Elementen für unser Filter ausgemessen haben, benötigen wir eine Software die es uns ermöglicht basierend auf den Impedanz Verläufen ein Filter auszulegen. Dafür benutzen wir die Software EFSyn.

In Bild 5 kann man das Fenster sehen, in welchem das Schema vom Filter gezeichnet wird. In einem ersten Schritt kann die gewünschte Filtertopologie gezeichnet werden. Nun verwenden wir anstelle der theoretischen Werte die gemessenen Werte der Filterelemente. Betrachten wir in Bild 5 das rot mar-kierte Element, verbirgt sich kein Spice Model dahinter. Es ist der Impedanz Verlauf den wir im ersten Schritt ausgemessen haben (siehe das Bild im Vordergrund). Diese Art von Simulation hat den Vor-teil, dass

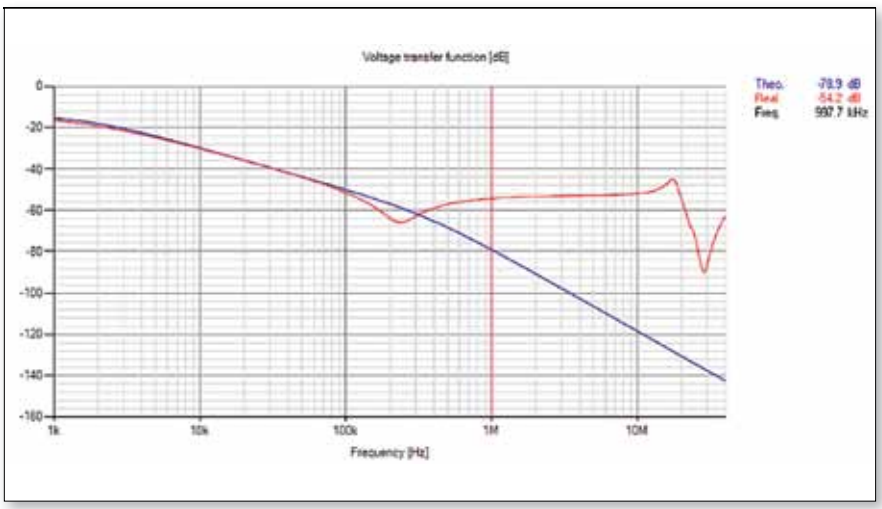


Bild 6: Simulation CMM Filter

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die Ergebnisse sehr genau sind. Ein weiterer Vorteil liegt in der hohen Flexibilität schnell neue Filterelemente auszumessen und für die weitere Simulation zu verwenden. Sobald die ausge-messen Bauteilen in der Bibliothek hinterlegt sind, kann man damit neue Filter mit allen parasitären Effekten simulieren.

OPTIMIERUNG: FILTERLEISTUNG IST SCHLECHTER ALS ERWARTET

In unserem Beispiel zeigen wir die parasitären Effekte an einem Common Mode Filter auf. Wir wissen das die leitungsgebundene Common Mode Störung im Frequenzbereich von 1MHz bis 30MHz domi-nieren. In diesem Frequenzbereich sind wir auf eine hohe Dämpfung angewiesen. Wen wir jetzt das Filter aus Bild 1 simulieren, erhalten wir das folgende Resultat:

Bild 6 zeigt die Simulation des Common Mode Frequenzverhalten mit idealen Bauteilen (Blau). Die rote Linie zeigt den Frequenzverlauf der Simulation basierend auf den gemessenen Bauteilen. Die Ausgangsimpedanz des Netzteils wurde zu 100 Ohm festgelegt. Die Impedanz auf der Netzseite wur-de auf 25 Ohm festgelegt. In Bild 6 sehen wir eine erste Resonanzfrequenz bei 200 kHz. Dies ist die Frequenz ab der die Common Mode Drossel kapazitiv wirkt. Bei ca. 20 MHz sehen wir eine zweite Resonanzstelle. Diese wird bestimmt durch die Streuinduktivität der Common Mode Drossel. Bei 30MHz erkennen wir die Resonanzfrequenz vom Y-Kondensator.

Der rote Marker bei 1 MHz zeigt uns eine Differenz von mehr als 20 dB zwischen der theoretischen Dämpfung und dem Resultat basierend auf den gemessenen Werten. Das bedeutet die Dämpfung des Filters ist bei dieser Frequenz 10-mal geringer als erwartet! Weitere Effekte die sich auf die Filterperformance auswirken sind noch nicht berücksichtigt!

Dies zeigt uns, dass es ungenügend ist, sich nur auf die theoretischen Werte zu verlassen.

PRAXIS: EIN BERICHT AUS DEM EMV LABOR

Wir arbeiten an einem Prototypen Schaltnetzteil, und suchen nach einer Lösung um die Leitungsge-bundenen Störungen zu minimieren. Wir ersetzten die 10 mH Common Mode Drossel mit einer 15mH Drossel. Wir entscheiden uns zu diesem Schritt weil wir davon ausgehen mit der 15 mH Drossel eine bessere Common Mode Dämpfung zu erreichen wie mit der 10mH. Theoretisch ein klarer Fall. Das Resultat in der Praxis ist wie folgt: Die Störungen werden im tieferen Frequenzbereich reduziert, im höheren Frequenzbereich treten die Störungen nun jedoch verstärkt auf. Das Hochfrequenz Verhalten von realen Filterelementen ist der Grund dafür. Eine baugleiche Drossel mit höherer Common Mode Induktivität weist vielfach ein schlechteres Verhalten bei hohen Frequenzen auf. Für die Höhere Induk-tivität brauchen wir mehr Windungen. Die parasitären Kapazitäten der Drossel werden dadurch ver-größert. Mit dem gezeigten Lösungsansatz, können diese Effekte berücksichtigt werden ohne viel Zeit mit der „cut and try“ Methode zu verlieren.

FAZIT

Um eine gute Lösung in möglichst kurzer Zeit zu finden, ist ein strukturiertes Vorgehen wichtig. Als erstes müssen wir wissen um welche Art von Störung es sich handelt und in welchem Frequenzbe-reich diese dominant sind. Für Störungen oberhalb von 1 MHz muss das RF Verhalten von den Filterelementen mit einbezogen werden. Eine Simulation die alle parasitären Effekte und Frequenzver-halten berücksichtigt, hilft bei der Findung eines optimalen Filters. Die Entwicklungszeit kann reduziert werden. Das Filter ist bei dieser Auslegung nicht falsch oder überdimensioniert was die Kosten vom Produkt reduziert. Die Simulation basierend auf den realen Filterelementen hilft dabei die EMV Filter-funktion besser zu verstehen.

[1] Simulationen und Messungen wurden mit EFSyn eine Software.

El. Ing. Eureta Tobias Hofer studierte Elektrotechnik an der ZBW St.Gallen. Seit 5 Jahren arbeitete er für die Firma Negal Engineering AG. Er beginnt eine Sparte für EMC Consulting. Sie erreichen ihn unter tobias.hofer@bluewin.ch.



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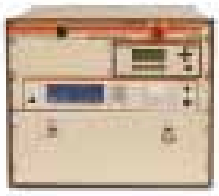


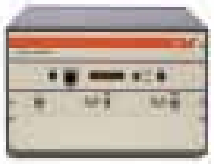
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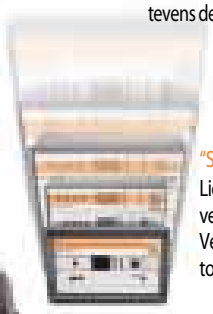
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Johan De Temmerman; johan.de.temmerman@moreatmere.com; www.bgemc.com
Produits et services: Contrôles

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+44-7817-731-000
Andy Bowne, Andy.Bowne@carlisleit.com; www.CarlisleIT.com
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The new CDN HSS-2 Coupling Decoupling Network is designed for surge testing of operational unshielded symmetrical high speed communication lines with 1.2/50 µs surge pulses. Test ISDN, Ethernet 10/100/1000BaseT or Power over Ethernet (PoE) lines with speeds up to 1000BaseT. Coupling configurations include 1, 2 or 4 pairs with a 40 Ω resistor and capacitor. High decoupling provides an Auxiliary Equipment (AE) independent pulse shape and ensures high measurement reproducibility. With a 2 kV surge test voltage, the peak residual pulse at the AE port is only 65 V and additional decoupling elements are not required. The CDN is designed in accordance with the coming edition of IEC/EN 61000-4-5 and can be used with Teseq's NSG series or any industry standard surge generator.

CDN HSS-2 at a glance:

- **ISDN, Ethernet and PoE compatible**
- **Test at speeds up to 1000BaseT**
- **High decoupling ensures test reproducibility**
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- **Use with any surge generator**
- **Complies with 3rd Edition of IEC 61000-4-5**

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DRYS TECHNIKI S.A.,
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+30 210 523 2842; Fax +30 210 52 32 555
drysales@drystech.gr; www.drystech.gr
Products and Services: Designers and Manufacturers of High Power Microwave and RF Amplifiers (Tetrode Tubes, Solid State and TWT)

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Products and Services: Amplifiers (RF & Microwave), Antennas, Automotive Systems, Conducted RF immunity, Conducted Surge & Transients, ESD, Harmonics & Flicker, GTEM cells, RF Immunity Systems, RF Emission Systems, RF Testsoftware, Calibration & Service

Czech Republic
AR RF/Microwave Instrumentation
H TEST a.s, Šafránkova 3,15500 Praha 5 Czech Republic; +420 235365207; Fax: +420 2353689;
David Koshuba; www.htest.cz
Products and Services: Amplifiers, Antennas, Cables & Connectors, Shielded Rooms & Enclosures, Surge & Transients, Test Instrumentation

Comtest - Probin
Praque, Czech republic
+420 221451370 Thomas Rathousky;
rathousky@probin.cz; www.comtest.eu
Products and services: Anechoic chambers, Reverberation chambers, RF shielded rooms & doors, Microwave absorbers.

CST AG, Branch Office Prague
Prazska 636, 25241 Dolni Brezany, Czech Republic
+420 257 219 488; vratislav.sokol@cst.com; www.cst.com
Products and Services: Testing, antennas, shielding, cable, software, plugs

EM TEST
Testovaci Technika s.r.o., Hakenova 1423,
290 01 Podebrady, Czech Republic;
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Products and Services: Surge & Transients, Test Instrumentation, Testing

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Products and Services: Filters, Shielding

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Products and services: Anechoic chambers, Reverberation chambers, RF shielded rooms & doors, Microwave absorbers.

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Geroge Koukas, info@vectortechnologies.gr
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Products and Services: Designers and Manufacturers of High Power Microwave and RF Amplifiers (Tetrode Tubes, Solid State and TWT)

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Luxembourg

A.H. Systems, Inc.
EEMCCOIMEX, Lelystad, NL
+31 320 295 395; Fax: +31 320 413 133
info@eemc.nl; www.eemc.nl
Products and Services: Antennas, Test Instrumentation, Testing

AR RF/Microwave Instrumentation
Frankrijklaan 7, ITC Boskoop, NL-2391 PX, Hazerswoude-Dorp, the Netherlands
+31(0) 17 242 30 00; Fax: +31(0) 17 242 30 09
Onno de Meyer, info@arbenelux.com; www.arbenelux.com
Products and Services: Amplifiers, Antennas, Cables & Connectors, Shielded Rooms & Enclosures, Surge & Transients, Test Instrumentation

Comtest Engineering bv
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+31-71 5417531; Info@comtest.eu; www.comtest.eu
*Products and services: A*nechoic chambers, Reverberation chambers, RF shielded rooms & doors, Microwave absorbers.

EM TEST GmbH
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info@emtest.de; www.emtest.com
Products and Services: Surge & Transients, Test Instrumentation, Testing

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HF Technology, Atalanta 5, 1562 LC Krommenie Holland
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info@hftechnology.nl
Products and Services: Antennas, Ferrites

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5653 LC Eindhoven, The Netherlands;
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Products and Services: Surge & Transients, Test Instrumentation, Testing

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Norway

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2382 NV Zoeterwoude, The Netherlands
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Schlegel Electronic Materials
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Products and services: Conductive materials, shielding

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Products and Services: Filters, Shielding

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Sergey Pavlov, ps@ranet.ru; www.radiant.su
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Products and Services: Amplifiers

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info.russia@rohde-schwarz.com www.rohde-schwarz.ru
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+7 916 543 50 30; eiSos-russia@we-online.com
Products and Services: Cables & Connectors, Ferrites

Serbia

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+31(0)172 423 000; Fax: +31(0)172 423 009;
Onno de Meyer, info@arbenelux.com; www.arbenelux.com
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Sweden

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