DECEMBER 2010

IN COMPLIANCE™ Magazine

THE COMPLIANCE INFORMATION RESOURCE FOR ELECTRICAL ENGINEERS

NARROWBAND AND BROADBAND DISCRIMINATION

WITH A SPECTRUM ANALYZER OR EMI RECEIVER

Harmonic Measurement for IEC 61000-4-3

MIL-STD-464B: A Review of the Latest Revisions to the Standard Part 1

Fundamentals of ESD Part 5

Are Standards Still Important?

COMPLIANCE MARKETPLACE Test Equipment

Dear Readers,

Here we are – the December issue, the last issue of 2010. I am in awe of the incredible words of support and gratitude that we've heard from you during the year. Thank you for being so willing to interact and tell us what you need. Your feedback helps us bring you a great magazine each month so please keep your comments and suggestions coming. You can email me at editor@incompliancemag.com

Beginning in 2011 we'll be running a new monthly feature in the magazine and we need your participation to start things up and keep them going. We want to run your stories – stories of how you overcame compliance engineering challenges that stood in the way of your product passing the hurdles on the road to compliance, stories of how things could have gone terribly wrong but because of your engineering prowess, you saved the day! The more colorful the story, the more fun we'll have with it. We're calling this new feature "Reality Engineering."

So, let's hear from you. You can email your stories to reality.engineering@incompliancemag.com or if you prefer to send a letter, the address is IN Compliance Magazine, Reality Engineering Department, PO Box 235, Hopedale, MA 01747.

And as we approach the holiday season, we wish you a peaceful, happy transition into 2011. We are so very grateful for your participation in making *IN Compliance Magazine* your first choice publication.

Very best regards,

Lorie Nichols
Editor

IN COMPLIANCE Magazine

Lorie Nichols
Publisher & Editor
(978) 873-7777
lorie.nichols@incompliancemag.com

Sharon Smith
Director of Sales
(978) 873-7722
sharon.smith@incompliancemag.com

Barbara Kovalchek
Media Consultant
(978) 846-1656
barbara.kovalchek@incompliancemag.com

Erin C. Feeney
Director of Media Services
(978) 873-7756
erin.feeney@incompliancemag.com

IN Compliance Magazine
ISSN 1948-8254 (print)
ISSN 1948-8262 (online)
is published by

Same Page Publishing LLC
P.O. Box 235
Hopedale, MA 01747
tel: (508) 488-6274
fax: (508) 488-6114

IN Compliance Magazine subscriptions are free to qualified subscribers in North America.

Subscriptions outside North America are $129 for 12 issues. The Digital Edition is free.

Please contact our circulation department at circulation@incompliancemag.com

For information about advertising with IN Compliance, please contact

Sharon Smith at 978-873-7722
sharon.smith@incompliancemag.com

Barbara Kovalchek at (978) 846-1656
barbara.kovalchek@incompliancemag.com

FCC Broadens School and Library Access to High-Speed Internet

As part of its effort to provide universal, high-speed Internet access to all citizens, the Federal Communications Commission (FCC) has modified the provisions of its E-rate program for schools and libraries.

The Commission's E-rate program (formerly known as the Schools and Libraries Universal Service program) provides up to $2.25 billion annually to support telephone and Internet connections at schools and libraries across the country. However, the Commission believes that high-speed broadband access is now essential to meet the speed and capacity needs of students, teachers and library patrons, and that the E-rate program emphasis on basic broadband access must be expanded to address that need.

Under the terms of a Report and Order issue in September 2010, the Commission's modifications to the E-rate program include the following changes:

- Schools and libraries will now be able to use E-rate funds to connect to the Internet in the most cost-effective way possible, including existing state, regional and local networks, as well as unused fiber optic lines already in place.
- The cap on E-rate funding will now be indexed for inflation, with the additional funding coming from the Universal Service Fund. This change will allow schools to meet the increased price tag for high-speed Internet service.
- The process for educators and librarians to apply for E-rate funds will be streamlined.
- A pilot program will be launched to support wireless Internet connectivity for mobile learning devices.

Schools and libraries will now be able to use E-rate funds to connect to the Internet in the most cost-effective way possible, including existing state, regional and local networks, as well as unused fiber optic lines already in place.

- Schools will be given the opportunity to share their high-speed broadband Internet access with their local communities outside of school hours.

The Commission's Report and Order on its E-rate program modifications can be viewed at http://www.fcc.gov/Daily_Releases/Daily_Business/2010/db1001/FCC-10-175A1.pdf.

Commission Moves to Improve Wireless 911 Services

The Federal Communications Commission (FCC) has taken steps to improve the ability of 9-1-1 emergency call centers to locate callers using wireless phones.

According to the Commission, nearly two-thirds of emergency calls received by 9-1-1 call centers originate from mobile handheld devices. But, the Commission's data also indicates that up to 40% of such emergency calls fail to provide accurate caller location information through the Enhanced 9-1-1 (E9-1-1) service.

Under a Second Report and Order issued in September 2010 by the Commission, wireless carriers will now be required to meet the Commission's wireless location accuracy requirements in more numerous and geographically smaller areas. In addition, wireless carriers will also be required to provide reliability data on each 9-1-1 call they process, allowing 9-1-1 call centers and emergency responders to better estimate the location accuracy of each call.

The Commission's Second Report and Order in connection with wireless 911 services is available at http://www.fcc.gov/Daily_Releases/Daily_Business/2010/db1018/FCC-10-176A1.pdf.

FCC Proposes Fine Against Taxi Company for Illegal Transmissions

The Federal Communications Commission (FCC) has proposed a $20,000 fine against a Florida taxi operator who failed to cease operating an unlicensed radio transmitter, despite receiving multiple verbal warnings from FCC field agents.

According to a Notice of Apparent Liability for Forfeiture issued by the Commission in September 2010, American Taxi Shuttle and Limo, Inc. of Daytona Beach, FL repeatedly transmitted unlicensed radio communications on the 152.3900 MHz frequency in late 2009. The taxi company owner reportedly told FCC agents that the radio transmitters, along with the right to operate on the 152.3900 frequency, had been purchased from The Plaza Resort & Spa for use in his taxi operation. However, the owner was unable to provide the FCC with written documentation supporting his claim, and The Plaza Resort & Spa denied that any agreement to transmit on their assigned frequency had been reached.

Despite repeated verbal warnings from FCC agents that continued transmission on the contested frequencies was in violation of FCC rules, and verbal instructions to cease such transmissions, the taxi company continued its transmissions, ultimately resulting in the Notice of Apparent Liability for Forfeiture and the proposed fine.

The complete text of the Commission's Notice of Apparent Liability can be viewed at http://www.fcc.gov/Daily_Releases/Daily_Business/2010/db0924/DA-10-1803A1.pdf.

EU Commission Revises Exemption List for RoHS Directive

In an effort to reflect the latest scientific and technical progress in developing alternatives to hazardous materials used in electrical and electronic equipment, the Commission of the European Union (EU) has amended its list of products exempt from provisions of its directive 2009/95/EC, also known as the RoHS Directive.

Published in September 2010 in the *Official Journal of the European Union*, the Commission Decision provides a revised version of the complete Annex to the RoHS Directive. The revised Annex ends the exemption for certain products, and sets expiration dates for the exemptions currently granted to other products.

Of particular interest is the Commission's position regarding the repair of in-service electrical and electronic devices that are no longer exempt under the revised RoHS requirements. According to the Decision, original spare parts containing hazardous materials that are otherwise banned may be used to repair only those devices that were placed on the market before the exemption expired or was terminated.

The Commission's decision, including the complete text of the revised Annex to the RoHS Directive, can be viewed at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:251:0028:0034:EN:PDF. A correction to certain entries in the revised Annex was subsequently issued, and can be viewed at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:254:0048:0048:EN:PDF.

New List of Standards for the EU's Machinery Directive

The Commission of the European Union (EU) has issued an updated list of standards that can be used to demonstrate compliance with the essential requirements of its Directive 2006/42/EC, also known as the Machinery Directive.

The EU's Machinery Directive defines the essential health and safety requirements for a wide range of products, including: machinery and partly completed machinery; lifting accessories; chains, ropes and webbing; interchangeable equipment; removable mechanical transmission devices; and safety components.

The Directive's scope specifically excludes electrical and electronic products covered under Directive 73/23/EEC (the so-called Low Voltage Directive), including household appliances, audio and video equipment, informational technology equipment and ordinary office machinery.

The extensive list of CEN and Cenelec standards for the Machinery Directive was published in October 2010 in the *Official Journal of the European Union*, and replaces all previously published standards lists for the Directive.

The revised list of standards can be viewed at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:284:0001:0047:EN:PDF.

EU Commission Releases RAPEX Statistics for September 2010

The Commission of the European Union (EU) has released statistics on notices of unsafe consumer products that have been processed through the EU's rapid information system (RAPEX) during September 2010.

According to the Commission's report, 157 validated notifications of unsafe products (those posing either serious or moderate risk) were processed through the RAPEX system during the month. This compares with just 105 reports of unsafe products processed through the system during the comparable period in 2009.

Of the notifications received during the period, 52 (36%) were related to clothing, textiles and fashion items, with an additional 36 (25%) related to toys, and 9 (6%) related to electrical appliances. The risk of electric shock and fire was identified in 10 of the notifications (6%).

Regarding the country of origin identified in connection with products posing a serious safety risk, more than half of all notifications (88, or 61%) were related to products originating from China, including Hong Kong. Another 17 notifications (12%) of unsafe products originated in EU Member States. Fourteen notifications (10%) failed to identify any country of origin.

To view the complete text of the Commission's updated report on RAPEX statistics, go to http://ec.europa.eu/consumers/safety/rapex/docs/stats_09-2010.pdf.

Home Improvement Books Recalled

Oxmoor House, Inc., a publisher based in Birmingham, AL, has issued a second recall in 10 months for certain titles of its home improvement books published under the Sunset and Southern Living imprints.

The most recent recall involves about 540,000 copies of the company's books, and follows a recall in January 2010 involving about 951,000 copies. In both instances, the publisher says that the books contain errors in the technical diagrams and wiring instructions that could lead consumers to incorrectly install or repair electrical wiring. These errors could lead to conditions posing an electrical shock or fire hazard to consumers.

Oxmoor House reports that it has not receive any reports of incidents related to the erroneous diagrams and instructions, but has expanded its earlier recall to prevent any incidents from occurring in the future.

The recalled book titles were sold through home improvement stores and bookstores nationwide from 1955 through December 2005 for between $5 and $20. While the books have been out of print since then, the company warns that some consumers may still have copies of the books in their possession.

Additional information about this recall, including the titles of the books involved, is available at http://www.cpsc.gov/cpscpub/prerel/prhtml11/11701.html.

Company Issues Recall for Defective Circuit Breakers

Siemens Industry Inc. of Alpharetta, GA has announced the recall of about 2.2 million of its Siemens and Murray brands of circuit breakers, load centers and meter combinations, all manufactured in Mexico.

Siemens reports that the recalled devices have a spring clip that can break during normal use, leading to the loss of force required to maintain a proper electrical connection in the panelboard. According to the company, this defect can lead to excessive temperature, arcing or thermal damage at the connection point, and damage to the panelboard's electrical insulation, and can result in a fire, property damage, or personal injury.

Siemens says that it has received one report of a circuit breaker spring clip that broke during installation, but no reports of injuries.

The recalled devices were sold at The Home Depot, Lowes and other hardware and building supply stores and electrical distributors nationwide from June 2010 through August 2010 for between $2.50 and $235.

Additional information regarding this recall is available at http://www.cpsc.gov/cpscpub/prerel/prhtml10/10354.html.

Recalled Fluorescent Light Bulbs May Pose Burn Hazard

Eastern America Trio Products of Flushing, NY is recalling about 124,000 compact fluorescent light bulbs manufactured in China.

According to the company, the recalled light bulbs can overheat and catch fire, posing a potential fire and burn hazard to consumers. Eastern America says that is has received four reports of incidents related to the light bulbs, including two fires that resulted in minor property damage.

The recalled fluorescent light bulbs were sold in discount stores in New York, New Jersey, Pennsylvania and Connecticut from January 2008 through December 2008 for between $1 and $1.50.

Additional information regarding this recall is available at http://www.cpsc.gov/cpscpub/prerel/prhtml11/11001.html.

Recalled Fire Alarm Control Panels May Fail to Alarm

Fire-Lite Alarms of Northford, CT has recalled about 530 of its fire alarm control panels manufactured in the United States.

The company says that, when used with an expander module, the recalled fire alarm control panels can fail to sound an alarm in the event of a fire, posing a risk of fire and burn hazards to consumers. Fire-Lite says that it has not received any reports of incidents related to the defective fire alarm control panels, but has initiated the recall to prevent any such incidents in the future.

The control panels were sold through authorized wholesalers and distributors nationwide from October 2008 through March 2010 for about $2285 for the fire alarm control panel, and $875 for the expander module.

Additional information regarding this recall is available at http://www.cpsc.gov/cpscpub/prerel/prhtml11/11702.html.

Standards Update – UL

Underwriters Laboratories has announced the availability of the following standards, revisions and bulletins. For additional information regarding the standards listed below, please visit their website at http://www.ul.com.

- **UL 62**: **Flexible Cords and Cables**
  Revision dated October 20, 2010
- **UL 65**: **Standard for Wired Cabinets**
  New Edition dated October 26, 2010
- **UL 94**: **Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances**
  Revision dated October 21, 2010
- **UL 96**: **Standard for Lightning Protection Components**
  Revision dated October 4, 2010
- **UL 96A**: **Standard for Installation Requirements for Lightning Protection Systems**
  Revision dated October 4, 2010
- **UL 103**: **Standard for Factory-Built Chimneys for Residential Type and Building Heating Appliances**
  New Edition dated October 15, 2010
- **UL 312**: **Standard for Check Valves for Fire-Protection Service**
  New Edition dated September 30, 2010
- **UL 404**: **Standard for Gauges, Indicating Pressure, for Compressed Gas Service**
  New Edition dated October 8, 2010
- **UL 746A**: **Standard for Polymeric Materials - Short Term Property Evaluations**
  Revision dated October 27, 2010
- **UL 746C**: **Standard for Polymeric Materials - Use in Electrical Equipment Evaluations**
  Revision dated October 28, 2010
- **UL 796**: **Standard for Printed-Wiring Boards**
  New Edition dated October 8, 2010
- **UL 796F**: **Standard for Flexible Materials Interconnect Constructions**
  New Edition dated October 25, 2010
- **UL 796F**: **Standard for Flexible Materials Interconnect Constructions**
  Revision dated October 25, 2010
- **UL 1047**: **Standard for Isolated Power Systems Equipment**
  New Edition dated October 7, 2010
- **UL 1083**: **Household Electric Skillets and Frying-Type Appliances**
  Revision dated October 20, 2010
- **UL 1090**: **Standard for Electric Snow Movers**
  New Edition dated October 01, 2010
- **UL 1247**: **Standard for Diesel Engines for Driving Stationary Fire Pumps**
  Revision dated October 14, 2010
- **UL 1254**: **Standard for Pre-Engineered Dry Chemical Extinguishing System Units**
  Revision dated October 8, 2010
- **UL 1310**: **Standard for Class 2 Power Units**
  Revision dated September 30, 2010
- **UL 1449**: **Standard for Surge Protective Devices**
  Revision dated October 18, 2010
- **UL 1482**: **Standard for Solid-Fuel Type Room Heaters**
  Revision dated October 8, 2010
- **UL 1653**: **Electrical Nonmetallic Tubing**
  Revision dated October 26, 2010
- **UL 1686**: **Standard for Pin and Sleeve Configurations**
  Revision dated October 1, 2010
- **UL 1738**: **Standard for Venting Systems for Gas-Burning Appliances, Categories II, III, and IV**
  New Edition dated October 4, 2010
- **UL 60730-2-9**: **Standard for Automatic Electrical Controls for Household and Similar Use - Part 2-9: Particular Requirements for Temperature Sensing Controls**
  New Edition dated October 13, 2010
- **UL 60730-2-2**: **Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Thermal Motor Protectors**
  Revision dated October 12, 2010
- **UL 60745-2-1**: **Hand-Held Motor-Operated Electric Tools - Safety - Part 2-1: Particular Requirements for Drills and Impact Drills**
  Revision dated October 6, 2010

Fully Automated EMC Testing Easier & Better Than Ever.

With More Control And A More Intuitive Interface.

AR's new SW1007 software performs Radiated Susceptibility and Conducted Immunity tests automatically. So that's one less thing you have to worry about. Actually, it's a lot less things – including test accuracy and customized test reports.

New features include:

- New user interface that's easier to navigate
- Tracking/notification of equipment calibration dates
- Ability to control more equipment
- Updated test set-up screen
- Improved report control
- More calibration options:
  The SW1007 comes with standards built in:
  IEC/EN, DO160, MIL-STD-461. GR1089, ISO/Automotive. You can change the test standards with just one click; and adding test standards is simple.

FREE Software Available Now!

To request your free SW1007 EMC test software, complete the form at www.ar-worldwide.com/SW1007. Or ask your AR sales associate for a free hard copy. It's easy to use. It's accurate and it's free. That's a win/win/win. Unless, of course, you really enjoy spending all that time running tests manually.

To learn more, visit www.ar-worldwide.com or call us at 215-723-8181.

ISO 9001:2008
Certified

ar®

rf/microwave instrumentation

Other ar divisions: modular rf • receiver systems • ar europe

USA 215-723-8181. For an applications engineer, call 800-933-8181.

In Europe, call ar United Kingdom 441-908-282766 • ar France 33-1-47-91-75-30 • emv GmbH 89-614-1710 • ar Benelux 31-172-423-000

The iNARTE Informer

Provided by the International Association for Radio, Telecommunications and Electromagnetics

ASSOCIATE LEVEL CERTIFICATION

Over the last three months we have discussed the various Elements that are required to be satisfied in order to achieve iNARTE Certification, the four "Es" of Education, Experience, Examination and Endorsement. iNARTE Certification is intended to identify the truly capable individual, the proven problem solver who can bring real value to any organization.

But what if you want to start to build your career in one of the iNARTE disciplines, and you have a good education, a sound knowledge of the subject matter, enthusiastic referees, but little or no working experience. How can you get recognition of your special knowledge to get that first, or maybe second, position? iNARTE has introduced the **Associate Certification** for just such an individual; a new graduate or a practitioner with just a few years of experience, but with the ambition to be at the top of their engineering field.

ASSOCIATE INARTE CERTIFIED ENGINEER (INAE) AND ASSOCIATE INARTE CERTIFIED TECHNICIAN (INAT)

The iNARTE Associate Engineer Credential, iNAE, and Associate Technician Credential, iNAT, have been created as a stepping stone to full iNARTE Certification. They are intended to recognize the abilities of graduate engineers and technicians who have not yet accumulated the work experience required to meet iNARTE's traditional program criteria.

iNARTE Associate status is available in the disciplines of Electromagnetic Compatibility, EMC; Electrostatic Discharge Control, ESD; and Product Safety Engineering, PSE.

In today's adverse and competitive marketplace, recent graduates face severe competition for a limited number of positions. Employers need to identify the very best candidates to fill these positions. An iNARTE credential has long been recognized as a symbol of excellence, and the iNAE or iNAT certificate could be the deciding factor between a brilliant, rewarding career and settling for a less interesting option.

Not only can iNARTE help you get started, but we, together with our technology partners at the IEEE and the ESDA, will be there to provide opportunities for continuing professional development and personal growth.

GETTING STARTED

iNARTE has established several ways in which a young engineer or technician can become certified at the Associate level. This credential is available to qualified applicants with less than the 9 years, or 6 years, experience required for full iNARTE Certification:

The Accredited University or Training Institute Route

iNARTE has been given copies of the engineering curricula from a number of universities and other institutes having EMC, ESD or PSE related programs. Those with a sufficiently comprehensive program have been recognized as iNARTE Accredited. A list of such Institutes is available at the iNARTE web site. Graduates from an approved curricula at an iNARTE Accredited University or Institute, and carrying a GPA >3.0, can be awarded the Associate Certification with no further examination.

Examination

Graduates with a degree or diploma in Electronics, Physical Science or similar, from a non-Accredited Institute, will be required to pass an iNARTE Associate level examination. The Associate examination is a short form of the normal examination with just one four (4) hour paper covering the fundamentals of the discipline.

Alternatively any person at any stage of their education or early career can pass the full eight (8) hour iNARTE Certification examination and be awarded an Associate Certification that will automatically be upgraded when their experience years have been attained.

Associates who have been credentialed as a result of graduating from an accredited institute or by passing the short form examination will be required to pass a second short form examination before they can attain full certification status. This second examination will also be a four (4) hour paper with most questions based upon knowledge of the industry standards, instrumentation, methods of metrology and mitigating engineering (the type of knowledge usually gained through work experience).

Endorsement

New graduate applicants must provide a letter of endorsement from a professor or department head attesting to their scholastic aptitude and suitability for a career in the selected discipline. Applicants who are already in employment should provide a letter of reference from their immediate supervisor. If their employment has been for less than one year, we will require letters from both their supervisor and a professor at their last seat of learning.

New Questions

As further evidence that an applicant understands the discipline, iNARTE requires the submission of five (5) technical questions, each with four (4) multiple choice answers. The correct answers should be able to be determined in 6 minutes or less, and references or solutions need to be included.

Forms showing the reference requirements and the style and format of the five questions are included as part of the iNARTE Associate application pack to be found at http://www.narte.org/d/assocapp.pdf.

All new questions must be presented in electronic format, including all formulae, supporting calculations and explanatory figures. "Word" documents are preferred, but other formats are acceptable if they can be copied and pasted into the iNARTE data pools without transposition errors.

All new questions will be presented to a committee of experts for review. Unsuitable or incorrect questions will be returned to the candidate for correction.

Renewal

Associates may renew their certification each year until they have reached their normal certification experience requirement of nine (9) years for engineers and six (6) years for technicians. They can then renew for one further year, during which time they will be expected to complete whatever steps may remain for full certification. Each year of Associate certification renewal should be accompanied by a further five (5) new questions that follow the same style and format as those required for the initial certification.

Partners in Professional Development

iNARTE has formal Agreements in place with the following Engineering Groups:

- The IEEE Electromagnetic Compatibility Society
- The IEEE Product Safety Engineering Society
- The Electrostatic Discharge Association

Each of these groups has agreed that any iNARTE Associate Engineer or Technician will be awarded one free year of membership with all the associated rights and privileges. This would typically include attending local chapter meetings, special price attendance at annual symposia, training sessions and workshops and special discounted prices on standards, text books and other technical papers and proceedings. These local chapter and national meetings are great networking opportunities for the ambitious young engineer or technician.

FAQ: Can I take the examination before graduation?

ANS: The iNARTE full eight hour examination can be taken at any time. The initial short form Associate examination has to be after graduation. The second Associate short form examination can be attempted at any time after the first examination, but it is recommended that the applicant gain a few years of work experience before attempting this second examination.

FAQ: Where do I take the examination?

ANS: If you are still attending a university or training institute, we can normally arrange examination at your school. Alternatively all Authorized Test Centers are listed on the iNARTE web site. There are approximately 200 Centers and individual proctors listed there, and they are situated across the United States and overseas.

FAQ: What if there is no Test Center near me?

ANS: This can sometimes happen and iNARTE will then arrange testing at your place of work, at a local Community College, a library or a similar facility where a suitable proctor can be found.

FAQ: What do I have to do to get my full certificate?

ANS: If you have passed the iNARTE full examination, or passed both the first and second Associate level examinations, and met the other requirements for Associate certification, the only things we will need from you is an updated resume. If you have not previously taken the Associate examination, or have only passed the first Associate examination, then you will need to pass the second Associate examination and provide an updated resume.

FAQ: What if I fail the examination?

ANS: You can retake the examination as many times as you wish, allowing a period of 90 days between attempts.

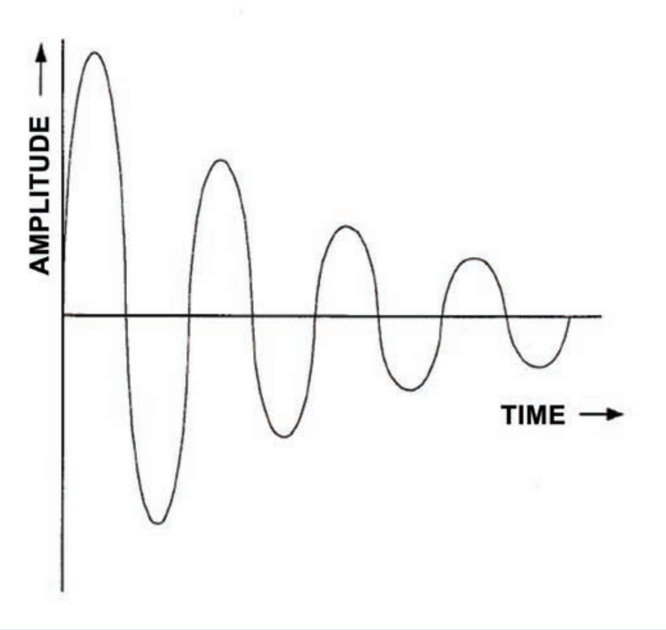
EMC QUESTION OF THE MONTH

The answer to last month's question is: C) 5.0 meters

This month's question is:

What is the damping factor of a damped sinusoid with the following parameters:

1. Peak current = 20A
2. Current at 50% decay = 7A
3. Number of cycles at 50% decay = 4



Choose the correct answer:

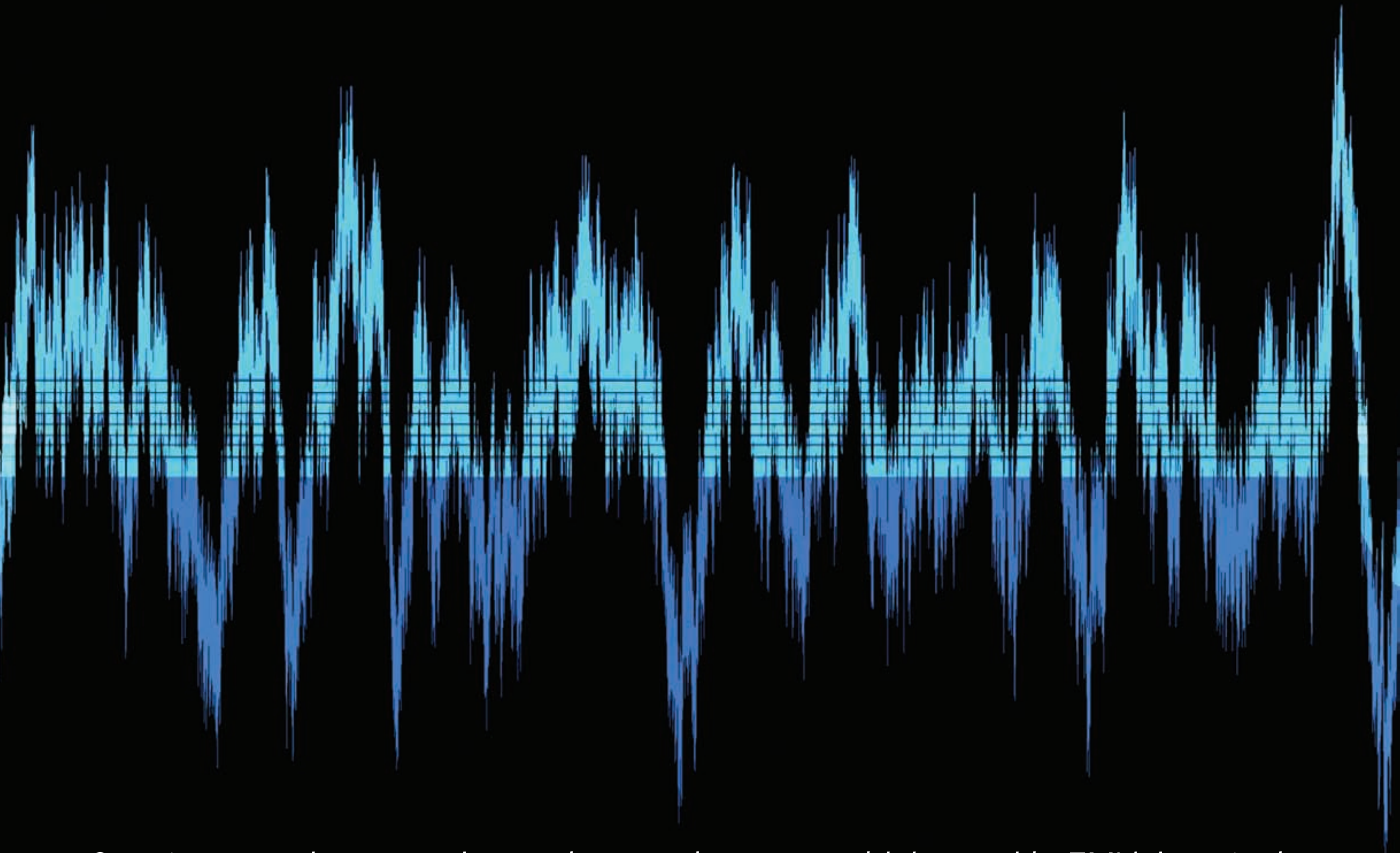
A) 5
B) 9
C) 11
D) 14

Watch for the answer in the next iNARTE Informer. ■

NARROWBAND AND BROADBAND DISCRIMINATION

with a Spectrum Analyzer or EMI Receiver

by Werner Schaefer



Spectrum analyzers and scanning receivers are widely used in EMI laboratories today. Their use for measuring both narrowband and broadband signals requires specific understanding of certain instrument and signal characteristics in order to correctly interpret the displayed results. This article explains methods for the discrimination between narrowband and broadband signals and provides guidance for the proper operation of test instrumentation.

In the field of EMC, the two main categories of signals encountered are of particular importance: narrowband signals and broadband signals. The International Electrotechnical Vocabulary (IEV) defines a narrowband disturbance as "*an electromagnetic disturbance, or component thereof, which has a bandwidth less than or equal to that of a particular measuring apparatus, receiver or susceptible device.*" Consequently, a broadband disturbance is defined as "*an electromagnetic disturbance which has a bandwidth greater than that of a particular measuring apparatus, receiver or susceptible device.*" This means that the classification of a signal as narrowband or broadband is determined by the occupied frequency spectrum of the signal under investigation, relative to the resolution bandwidth (RBW) of the instrument used for measurement. If the signal spectrum is completely contained in the passband of the IF filter, it is defined as a narrowband signal. The general definition of a narrowband and broadband signal is depicted in Figure 1. It is important to note that continuous wave (CW) signals are a specific case of narrowband signals, since they consist of only one spectral line which is within the passband of the intermediate frequency (IF) filter. This case is depicted in Figure 2 (right). If the occupied signal spectrum exceeds the bandwidth of the filter, the signal is considered to be broadband. This is the case for the spectra of pulses (which are coherent signals) and noise (non-coherent signals). This scenario is shown in Figure 1 (left). This article presents various methods that are suggested for the determination of signal characteristics in EMC standards and literature. It also discusses their advantages and disadvantages. The presented material builds on previous papers that addressed the measurement of impulsive signals and discussed test equipment parameters such as the definition of impulse bandwidth and the purpose of preselection. Therefore, this article will defer to previous publications for details, as necessary.

Narrowband and broadband signals can be generated by a variety of sources and usually represent different interference potentials for radio services. Very often an interference spectrum from equipment under test (EUT) contains both signal types. Since both signal categories require a different interpretation of the result measured with a spectrum analyzer or EMI receiver, it is essential to know the characteristics of a signal in order to correctly determine its frequency and amplitude. In some cases, the characteristics must be known in order to select the correct limit for the determination of EUT compliance. The measurement results displayed on these instruments are also dependent on some control settings, such as the sweep time and resolution bandwidth. Their impact on the measurement of signal parameters, like frequency and pulse width, must be understood to avoid erroneous interpretations of measurement results.

THE ROLE OF INSTRUMENT IF

Most modern scanning receivers, spectrum analyzers and traditional EMI receivers are super-heterodyne receivers using one or multiple stages to convert the frequency of the RF input signal to a fixed IF. This is achieved by mixing the unknown signal with a local oscillator (LO) signal in a mixing stage. Since a mixer is a non-linear device, its output includes not only the two original signals at the input but also

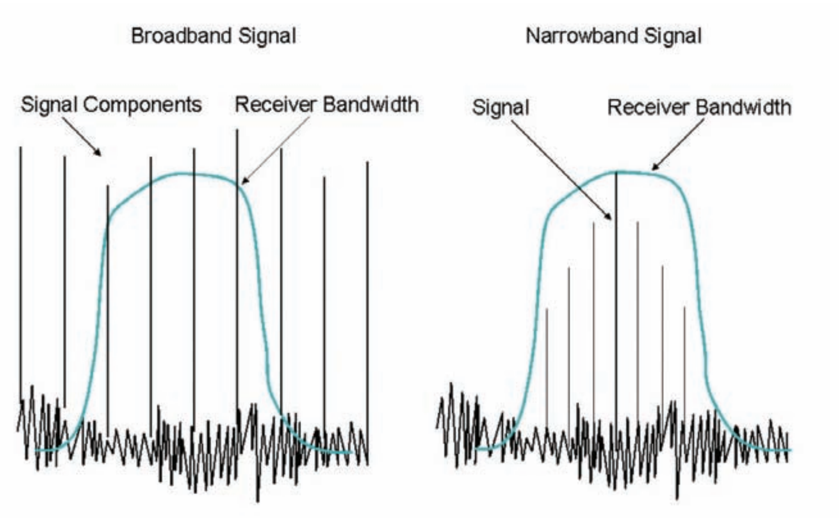


Figure 1: Generic definition of narrowband and broadband signals

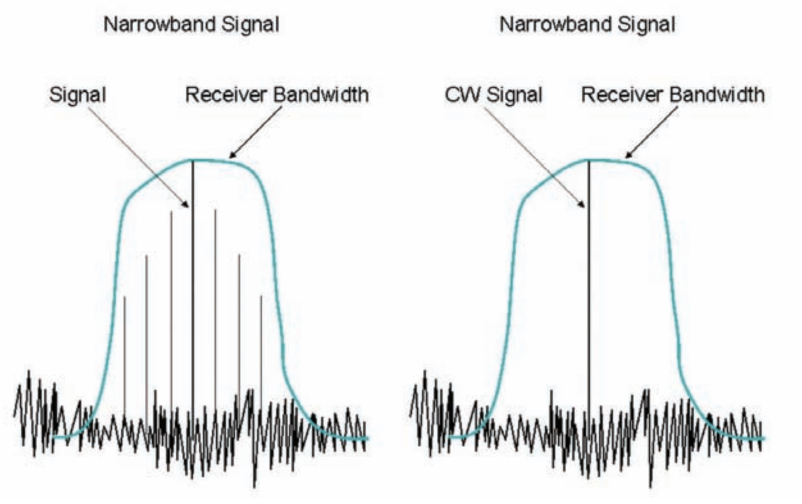


Figure 2: Two different types of narrowband signals

their harmonics and the sums and differences of the input signals and their harmonics. If any of the mixed signals falls within the passband of the IF filter, it is further processed at the IF and finally displayed. After the filtering, the signal is amplified by either a logarithmic or linear amplifier, rectified by the envelope detector, possibly filtered by a low-pass filter ("Video Filter") and finally graphically or numerically displayed.

EMI receivers as well as spectrum analyzers convert the IF signal to a video signal using an envelope detector. These signals have a frequency range from zero (dc) to some upper frequency which is determined by the detection circuit elements. In its simplest form an envelope detector consists of a diode followed by a parallel RC combination, as shown in Figure 3 (top). The output of the IF chain is applied to the detector. The time constants of the detector are chosen such that the voltage across the capacitor equals the peak value of the IF signal at all times which requires a fast charge and slow discharge time. In case the preceding resolution bandwidth of the receiver has only one spectral line in its passband (meaning, a CW signal is being measured), the IF signal is a steady sine wave with a constant peak amplitude. The output of the envelope detector will be a constant dc voltage without any variation for the detector to follow, as depicted in Figure 3 (top). However, often times there is more than one signal in the IF filter passband. For instance, in case of two sine waves, as shown in Figure 3 (bottom), these interact to create a beat note, and the envelope of the IF signal varies according to the phase change between the two sine waves. The maximum rate at which the envelope of the IF signals can change is determined by the resolution bandwidth. Since IF filters of receivers are not rectangular, the charge time of the detector needs to be a fraction of the reciprocal of the IF bandwidth (e.g. one-tenth) to obtain the envelope of the IF signal.

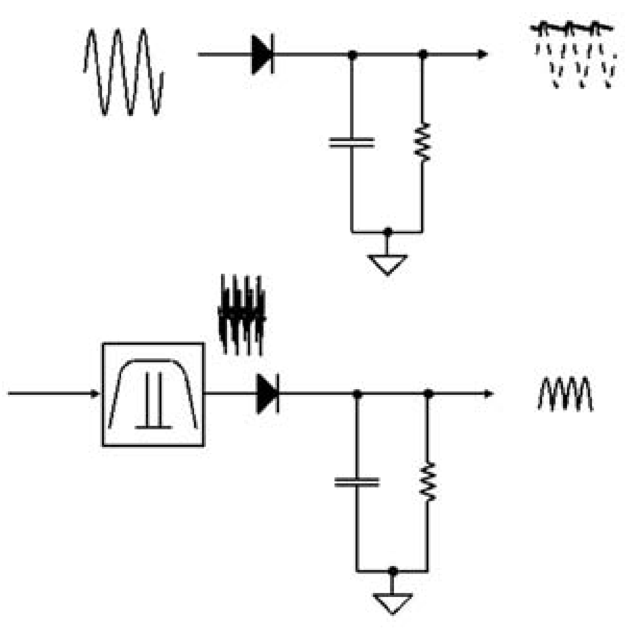


Figure 3: Envelope detector

Specific instrument parameters like the selected detector, resolution bandwidth and sweep time do have an impact on the displayed measurement result, dependent on the characteristics of the signal to be measured. Therefore, they can be used to determine if a signal is broadband or narrowband.

When using spectrum analyzers or receivers for EMI troubleshooting measurements, no standard is to be applied that calls out a specific setting of the IF bandwidth. Therefore, it is mandatory to know if a measured signal is displayed as a narrowband or broadband signal in order to correctly determine the frequency of signals. Furthermore, some EMI standards like the older MIL-STD 461B provide two different limits for narrowband and broadband signals, which require a determination of the signal characteristic as part of the compliance measurement process. In both cases, suitable discrimination methods are necessary to determine a signal to be narrowband or broadband.

RESOLUTION BANDWIDTH TEST

As mentioned before, the reference for a signal to be broadband or narrowband is the resolution bandwidth setting of the test instrument used for the measurement. Some standards suggest the variation of the resolution bandwidth of the test instrument and observation of the resultant amplitude change of the signal under investigation. It is stated that an amplitude change, introduced by the variation of the resolution bandwidth, indicates the presence of a broadband signal. Conversely, if no amplitude change is observed, the signal is considered to be narrowband. Figure 4 depicts the measurement of an impulsive signal with a pulse repetition frequency (PRF) of 1 kHz and a pulse width of 7.7 µsec. If this signal is initially measured with a 100 Hz resolution bandwidth and the bandwidth is changed to 300 Hz, no change in amplitude is observed. Bandwidth settings that are lower than the PRF of the signal to be measured will result in the resolution of each individual spectral component. This will result in a narrowband measurement of the signal. A further increase in resolution bandwidth to 10 or 30 kHz will result in multiple spectral components located in the passband of the IF filter. A change in resolution bandwidth will result in an amplitude change of the measured signal, since wider IF bandwidths will encompass more spectral components and thus result in higher levels at the filter output. Using bandwidth settings that are wider than the PRF will indicate the presence of a broad band signal, since amplitude changes can be observed. Further increases of the resolution bandwidth to 1 MHz or greater will not yield changes in signal amplitude. This would indicate the presence of a narrowband signal, which is incorrect, in accordance with the definition.

Getting ENERGY STAR® certification in 24 hours, very efficient.

As a manufacturer, you don't want spin. You want it straight. Your product isn't some pet project. That's why Intertek has Energy Efficiency solutions that bring home the you-know-what. For starters, we have the size and speed to save you both time and money. Our 18 Energy Efficiency testing laboratories across the globe have the capacity to get you up and out to market, faster. When the revised ENERGY STAR program kicks off on 1/1/11, you won't be waiting in line. With our core of energy expert reviewers ready to roll, barring any unforeseen non-compliance, you'll get ENERGY STAR certification in 24 hours after testing is complete.

In the meantime, you can secure Free ENERGY STAR testing with any new ETL certification by December 30th*. It's all part of our *Great American Energy Savings* campaign. Bolstered by 50 years of Energy Efficiency testing experience, from the innovators who brought you 15-day ETL testing, we deliver a package that helps products produce. So, steer clear of the mud. Get Intertek and get to market first. With our brand of efficiency, you can master the sales cycle.

ETL LISTED
Intertek

Free ENERGY STAR testing with each new ETL certification by 12/30/10*

1-800-WORLDLAB
www.intertek.com/energystar

Intertek

*Offer valid for ENERGY STAR testing fees up to $4,000. Contact an Intertek representative for details.

Large resolution bandwidths encompass the main spectral components of a signal (i.e., the main lobe and the first two side lobes of the spectrum), and do not lead to changes in the measured amplitude. Therefore, the variation of the resolution bandwidth as a means for determining the signal characteristic is of limited usefulness. Further information about the signal to be measured is required to avoid erroneous results. In addition, a change of bandwidth represents a change of the reference for the narrowband-broadband discrimination, which is very often neither permissible (by EMI standards) nor desirable for troubleshooting applications. It should be noted that this method provides conclusive results only when the signal under investigation is a CW signal.

PEAK VS. AVERAGE DETECTION TEST

A second discrimination for the determination of signal characteristics is the amplitude comparison between a peak and an average measurement. Both measurements are preferably made with the same instrument settings, especially with an identical resolution bandwidth setting. If no amplitude changes are observed between the two measurements, a signal is considered narrowband. A signal is considered broadband if an amplitude change between the two measurements is observed, with the average measurement yielding the lower amplitude. In practice, EMI standards that call out this discrimination method, like CISPR 25, specify an amplitude difference of, for example, 6 dB which is used as a decision criterion. Per CISPR 25, a signal is considered to be narrowband if the amplitude difference between the peak and average detected signal is less than 6 dB. If the amplitude difference is greater than 6 dB, the signal is determined to be broadband. This approach is meaningful since the relative amplitude accuracy of the instrument is to be considered as well as other uncertainty factors that are introduced by different instrument settings between the two measurements (e.g., change of reference level setting).

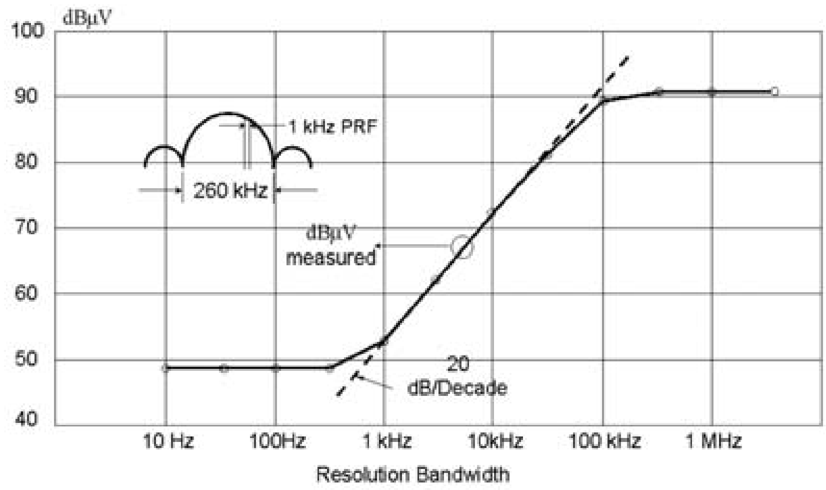


Figure 4: Impact of resolution bandwidth setting on measured amplitude of broadband signal

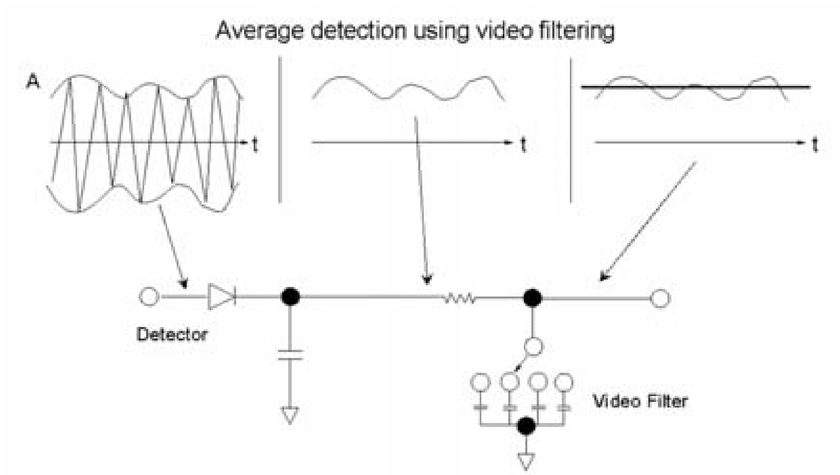


Figure 5: Peak versus average detection

Figure 5 demonstrates the principle of this method by depicting the functionality of the peak and average detector. The peak detector will determine the envelope of the signal to be measured, which results in a low frequency signal at the detector output or a DC signal in case the signal to be measured is a CW signal. Since the peak detector determines the amplitude envelope, it will provide the maximum signal amplitudes. The average detector is often implemented as a low pass filter that is placed after the peak detector in the signal processing chain. This low pass filter, often referred to as video filter, will be used as an integrator by setting the bandwidth value to either a predefined value, called out in a standard (e.g., CISPR 16-1-1, which specifies an integration time) or to a value that is smaller than the lowest spectral component of the signal to be measured. For example, a video bandwidth setting of less than 100 Hz will result in the display of the average value of the signal depicted in Figure 4. It should be noted that the instrument is to be used in linear display mode in order to obtain the average value of the signal under investigation. The proper video bandwidth setting can be easily determined empirically by reducing the video bandwidth step-by-step and observing the resultant amplitude change. If further reductions in video bandwidth do not cause further reductions in measured amplitude, the

Learn how to make EMC compliance tests in a three-day, hands-on course taught by experts.

Next Class:
Feb. 15 - 17, 2011
Austin, Texas

Our ***hands-on teaching*** method means ***you'll learn firsthand*** how to perform radiated and conducted emissions and immunity tests according to published standards.

Your ***instructors are experienced EMC experts*** with practical lab experience. You'll be taught exactly what to do, and know why you're doing it. Then, ***you'll apply what you've learned by making actual measurements in our 3 meter EMC chamber***. By taking this course, you'll avoid costly, time consuming trial-and- error methods, and learn practical, proven techniques that will have you ***become productive more quickly***.

Your tuition includes three days of personal instruction: a mix of classroom discussion and practical in-chamber testing.

You'll also receive ***a study guide and class notes*** so you can focus on learning, instead of taking notes. The study guide is a valuable reference tool you'll refer to often when you return to your lab. Also included are ***three days lodging*** at one of several nearby hotels, and ***delicious lunches*** served on site.

Class sizes are designed to be large enough to share and learn from a diversity of work experiences, yet small enough for individual attention.

This course is ideally suited for:

- EMC engineers or lab technicians who want to expand their knowledge of EMC testing
- Engineers or lab technicians new to EMC requirements
- Design engineers and anyone outsourcing their testing who wants to know the standards and test methods that will be applied to their products
- Non-engineers such as, business analysts or trade journalists, who want to understand the fundamentals of EMC testing
- Anyone preparing their lab for ISO/IEC 17025 accreditation
- Anyone preparing themselves for the iNARTE® personnel certification exam

BONUS!
All attendees receive a copy of Clayton Paul's book, *Introduction to Electromagnetic Compatibility.*

Need more info?
www.ets-lindgren.com/learning

Enabling Your Success™

ETS·LINDGREN™
An **ESCO Technologies** Company

Phone +1.512.531.6400 • info@ets-lindgren.com
Offices in the US, Finland, UK, France, Singapore, India, Japan, China, Taiwan

proper video bandwidth for making an average measurement has been found.

The comparison of peak and average detected signal amplitudes allows the conclusive determination of signal characteristics without changing the resolution bandwidth. This method can also be automated easily and thus allow further automation of the overall compliance measurement process.

SWEEPTIME TEST

The presence of broadband signals is easily noticeable when a measurement is performed with a scanning receiver or spectrum analyzer. Moving responses can be observed on the instrument display; their actual location and number are dependent on the relationship of the pulse period and the sweeptime setting of the instrument. Figure 6 (top graph) shows how a scanning receiver or spectrum analyzer intercepts an impulsive signal when a slow, single sweep and peak detection is used. The impulse envelope is depicted on the vertical frequency axis, and the occurrences of the impulse are indicated by vertical frequency lines spaced along the time axis. The impulse of the period TP is detected only half way through the receiver sweep. The measured amplitude at the detection instant is determined by the envelope of the pulse spectrum, as traced out by the IF bandwidth and represents the impulse response of the receiver to the input signal. The bottom graph of Figure 6 represents the scanning receiver's display, showing responses only at the detection instances. It is important to note that the pulse repetition frequency (PRF) **cannot** be determined directly from the display by measuring the frequency difference between two responses with marker functions, since a broadband signal is measured. The receiver's IF bandwidth is much wider than the PRF; thus the displayed responses are individual input pulses separated by the pulse period and the frequency and may be calculated from the sweep time of the receiver. The correct interpretation of the measurement result is difficult without prior knowledge of the presence of a broadband signal. After a single sweep, it is not obvious that the displayed responses are due to an impulse and not caused by individual sinusoidal signals or some type of modulation. However, a narrower measurement span and longer sweep time will lead to more intercepted pulses; hence the well-recognized sin(x)/x envelope shape will be traced out, and the impulsive signal will be easily identified. Broadband signals are displayed as time domain responses with amplitudes that are proportional to the envelope of the spectrum. With the instrument tuned to a particular frequency at a point in time, the spectral lines contained within the impulse bandwidth [1] around the tuning frequency, will add periodically at a rate corresponding to the signal PRF. As the analyzer is tuned to a different frequency, the maximum pulse amplitude will change in relation to the change in the envelope of the pulse spectrum. A scanning receiver or spectrum analyzer will therefore display a response every 1/PRF seconds with an amplitude proportional to the spectrum envelope at the tuning frequency of the instrument.

This phenomenon is used for the discrimination of narrowband and broadband signals. When changing the displayed frequency span on the instrument, the spacing of responses resulting from a broadband signal will not change, since they are a time phenomenon. In case of a narrowband signal, the responses are a frequency phenomenon and a change in span will cause a change in the spacing of the displayed responses. A change in sweeptime, however, will not affect the spacing of narrowband responses but have an impact on the spacing of the broadband responses. Slower sweeptimes will cause the display to show more responses, since more responses will be intercepted during a single sweep.

This discrimination method is useful to quickly determine the signal characteristic. However,

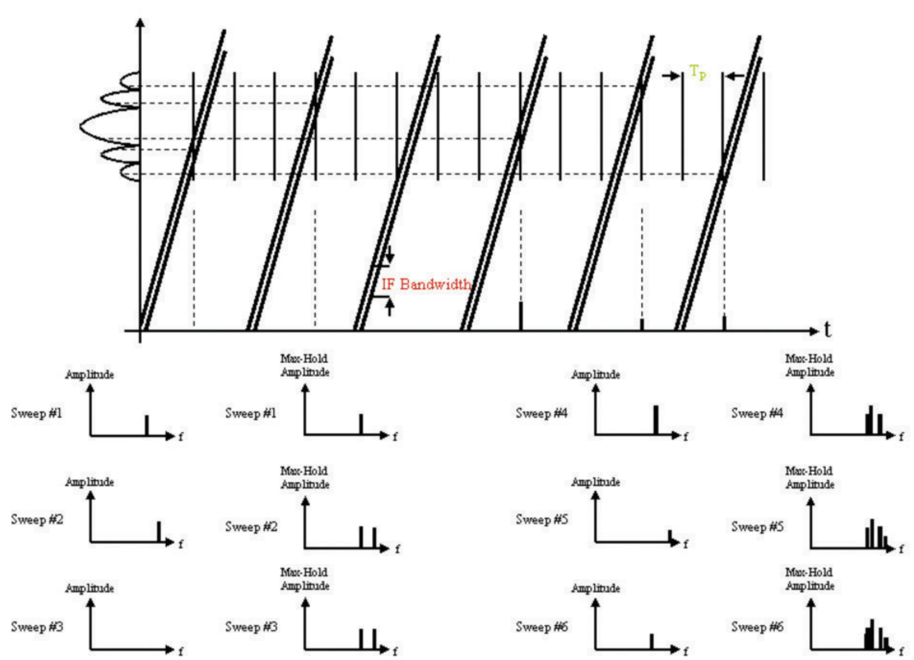


Figure 6: Broadband signal detection of a scanning receiver

if a complex spectrum is displayed, it may be difficult to observe the changes in spacing of responses.

TUNING TEST

Some older commercial and military EMC standards proposed a tuning test as a method for discrimination between narrowband and broadband signals. This test involves the de-tuning of a receiver by one or two impulse bandwidths to either side of the initial tuning frequency. The initial tuning frequency is to be identical with the frequency of the maximum signal response observed. The observed amplitude change on either side is then compared to a criterion (e.g., 3 dB or 6 dB) to determine if the signal is narrowband or broadband. If the de-tuning results in an amplitude change are greater than the criterion, the signal is considered narrowband. Conversely, if the amplitude change on either side of the initial tuning frequency is less than the criterion, the signal is determined to be broadband.

This method can provide inconclusive results when the de-tuning on one side of the maximum response is larger than the criterion, and on the other side a smaller amplitude variation is determined. This situation can occur if a signal spectrum is investigated that is rather complex, which may not allow the exact determination of the frequency at which the maximum response really occurs. Furthermore, this method requires the knowledge of the impulse bandwidth of the instrument, which is not identical to the 3 dB or 6 dB bandwidth of the measuring instrument. Furthermore, this method was initially based on the use of a fixed tuned receiver, as such, this approach is not suitable for automated testing.

SUMMARY

In the literature and standards, four main methods for the determination of signal characteristics are described. Their main aspects are summarized in Table 1.

Their advantages and limitations have been described, and the peak versus average detector method has been identified as most suitable. This method is also called out by most EMC standards that currently require the determination of signal characteristics as part of the compliance measurement process. ■

ACKNOWLEDGMENT

The author would like to thank Mrs. Tori Barling for proof reading this manuscript.

REFERENCES

1. W. Schaefer, "Understanding Impulse Bandwidth Specifications of EMI receivers," *IEEE International Symposion on EMC*, 1999, pp. 958-961.

2. W. Schaefer, "Measurement of Impulsive Signals with a Spectrum Analyzer or EMI receivers," *IEEE International Symposion on EMC*, 2005, pp. 267 – 271.

Werner Schaefer *is a compliance quality manager and technical leader for EMC and RF/uwave calibrations at Corporate Compliance Center of Cisco Systems in San Jose, CA. He has 25 years of EMC experience, including EMI test system and software design, EMI test method development and EMI standards development. He is the chairman of CISPR/A/WG1 and a member of CISPR/A/WG2 and CISPR/B/WG1. He also is the US Technical Advisor to CISPR/A and a member of ANSI C63, SC1/3/5/6/8, and serves as an A2LA and NVLAP lead assessor for EMI and wireless testing, software and protocol testing and RF/microwave calibration laboratories. He also serves as an ANSI representative to ISO CASCO, responsible for quality standards like ISO 17025 and ISO 17043. He is a member of the Board of Directors of the IEEE EMC Society.*

He was actively involved in the development of the new standard ANSI C63.10 and the latest revision of ANSI C63.4, mainly focusing on test equipment specifications, use of spectrum analyzers and site validation procedures.

Werner Schaefer is also a RAB certified quality systems lead auditor, and a NARTE certified EMC engineer.

He published over 50 papers on EMC, RF/uwave and quality assurance topics, conducted numerous trainings and workshops on these topics and co-authored a book on RF/uwave measurements in Germany.

Discrimination Method	Narrowband	Broadband
Bandwidth Test (par. 3)	No change in amplitude	Change in amplitude
Peak vs. Average Test (par. 4)	No change in amplitude	Change in amplitude
Sweeptime Test (par. 5)	No change in response spacing	Change in response spacing
Tuning Test (par.6)	Δ amplitude > 3dB (6 dB)	Δ amplitude < 3dB (6 dB)

Table 1

Harmonic Measurement for IEC 61000-4-3

and other Radiated Immunity Standards

Jason Smith, Applications Engineer Manager
Pat Malloy, Senior Applications Engineer
AR RF/Microwave Instrumentation

In the rush to complete RF immunity testing on schedule, it is not all that unusual to overlook inherent test equipment limitations. While some test equipment characteristics such as power amplifier harmonics are obviously a limiting factor, the broadband characteristics of antennas, directional couplers, power meters and isotropic field probes can hardly be considered a limitation for most applications. However, when used with power amplifiers exhibiting significant harmonic distortion in Immunity test systems, the broadband characteristics of these devices can result in measurement uncertainty and unacceptable errors.

A case in point is the ubiquitous broadband isotropic field probe that provides an E-field reading representative of the total energy from all frequencies within its operating band. Given the ideal, albeit rare, case of a pure sinusoidal signal, field probes provide an extremely accurate reading. To the extent that additional frequencies are present, errors are introduced and depending on the number and strength of the additional signals, a point is reached where the field reading is totally unrepresentative of the required test level at the desired frequency. The most troublesome unwanted frequencies are harmonics generated by RF test system nonlinearities. Often power amplifiers, especially those driven into saturation, are a major source of harmonics. To a lesser extent, signal sources, directional couplers and antennas exhibit some degree of nonlinearity and also contribute to the system level harmonics. Accordingly, the IEC 61000-4-3 has instituted system requirements intended to limit the allowable harmonic levels in the test field.

While it is imperative to consider instrument harmonic levels supplied by instrument vendors, test engineers must also confirm manufacturer's data by testing. While this article specifically addresses ways to check for harmonic levels mandated by IEC 61000-4-3, the procedures can be readily applied when testing to other RF immunity standards.

HARMONICS

Harmonics are unwanted frequencies generated by system nonlinearities. They are multiples of the fundamental test frequency, and generally, the higher the multiple, the less the amplitude of the harmonic. All "real" test systems have a finite amount of nonlinearities, and thus, exhibit some degree of harmonic distortion. The test engineer must ultimately determine acceptable levels of harmonics. His determination is primarily based on test standard mandates. In EMC testing applications, RF power amplifiers are responsible for most of the unwanted harmonics.

UNDERSTANDING HARMONICS IN AN AMPLIFIER

All amplifiers exhibit harmonic distortion to some extent. While some applications like industrial RF heating and plasma generation are not affected by harmonics, high levels of signal distortion will introduce unacceptable errors when testing for EMC immunity. Accordingly, harmonic distortion is a key power amplifier specification. It has been proven that properly designed Class A amplifiers when operated in their linear region have acceptable levels of harmonics and are an ideal choice for EMC test applications.

Keep in mind that even a properly designed, robust Class A RF power amplifier does not guarantee a distortion free test field. Care must be taken to operate within the linear range of the amplifier, even at the sacrifice of a smaller output signal. While driving the amplifier harder will indeed provide greater field strength, the inherent signal distortion resulting from a spike in the harmonic levels will introduce uncertainty and error in the resultant E-field. Ultimately, the question becomes, "Just how much input signal is required to ensure the desired signal purity in any given application." It can be seen that an EMC amplifier should not be operated beyond the 1dB compression point. In fact, operating in a more linear region below the 1dB will drastically minimize harmonics. Another less desirable option is the use of harmonic filtering at the output of the amplifier. Since this approach adds cost, insertion loss and complexity to the system, it should only be considered when there is no other practical option. For example, some TWT amplifiers are best served by the use of harmonic filters.

Since it is all but impossible to predict the cumulative effect of all the system devices on the purity of the E-field, a system level measurement must be taken. While vendor data should be consulted and relied on when selecting a power amplifier, there is no substitute for actual system measurements when it comes to validating the viability of a system design.

HOW DO MULTIPLE SIGNALS INFLUENCE POWER MEASUREMENT?

Most field probes and power heads use diode sensors with broadband characteristics. These devices are not frequency selective and will measure all signals within their operating range. The resultant reading is the square root of the sum of the squared amplitude of the fundament and all harmonics present. Clearly, harmonics will add proposition. Thus, the conundrum is determining what would be an acceptable level. Fortunately IEC 61000-4-3 provides guidance in this area. The latest version of IEC 61000-4-3 states the following: "For all frequencies where harmonics are produced at the output of the amplifier, the rejection of these harmonics in the field by more than 6 dB below the fundamental is adequate." In other words, there is now a 6dBc harmonic requirement in the test field. Note that dBc is a measurement of a specific harmonic level in relation to the carrier. A measurement of -6dBc by definition means that the amplitude of the harmonic is 6dB less than the carrier amplitude. Past IEC 61000-4-3 standards have specified the output harmonic level from the power amplifiers. The latest version of the standard considers the entire system when it mandates a 6dBc requirement. This level takes into account the fact that the transmitting antenna operates more efficiently at the 3rd harmonic than at the fundamental. It is not uncommon to see as much as a 5dB gain variation. As discussed in IEC 61000-4-3 annex D, limiting all harmonics in the test field to -6dBc will result is no more than a 10% field strength error. Figure 1 graphically plots this relationship. Note that with a -6dBc harmonic level a field probe reading of 10V/m actually represents about a 9V/m carrier level. If the test calls for more accuracy, the harmonics must be further reduced. For example, a 5% error in field strength requires the harmonic to be at least -10dBc. Standards that do not take into consideration the effect of the transmitting antenna concentrate on the power amplifier harmonics. For example, older versions of IEC 61000-4-3 limited amplifier harmonic levels to -15dBc. When compared to the new -6dBc total field specification, the -15dBc results in slightly less field level error.

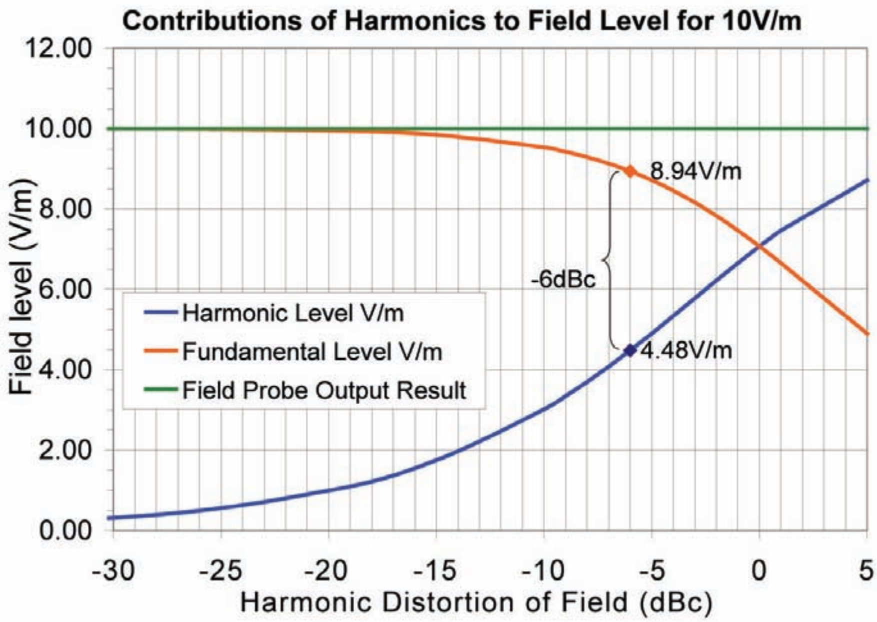


Figure 1: Single Harmonic Contribution to Measured Field

METHODS OF MEASUREMENT

There are two generally accepted methods used to determine the harmonic content of a test field. In both cases a frequency selective device is required to measure the level of the fundamental frequency as well as the harmonics. The most popular instrument used for this purpose is a spectrum analyzer. The required frequency range of the spectrum analyzer is determined by the frequency range mandated in the EMC standard. For example, since IEC 61000-4-3 covers 80MHz to 6GHz, the spectrum analyzer should have a minimum bandwidth of 80MHz to 18GHz in order to respond to at least the 3rd harmonic. For the rare occasion where there is significant harmonic content beyond the 3rd harmonic, a higher frequency analyzer is required. In most cases harmonic levels are inversely proportional to frequency and are not a factor outside the operating band of the amplifier. Since there are some

exceptions to this general rule, it is prudent to always verify harmonic levels by testing. One needs to look no further than to some TWT amplifiers which exhibit significant harmonics well beyond the frequency band of the amplifier. The message here is to be keenly aware of the predicted harmonic levels as published by the amplifier manufacturer, but always test to verify the published data.

RECEIVE ANTENNA METHOD

The test setup used for this method replicates that used for the actual test. Since the harmonics are measured directly without the need for calculations, it is the preferred method providing the most accurate data.

Required Equipment

- Spectrum analyzer 80MHz – 18GHz
- Receive antennas
- Coax cables, calibrated for losses
- Optional: Control software

Selection of Equipment

As noted above, the spectrum analyzer used is primarily determined by the test frequency range of the EMC test standard. The IEC 61000-4-3 covers 80MHz to 6GHz. To measure out to the 3rd harmonic, the spectrum analyzer must cover 80MHz to 18GHz. An ideal solution for the receive antenna would be one that covered the entire frequency range of 80MHz to 18GHz. Since typically this is not possible, the next best approach is to break the overall band up to coincide with the band breaks of the transmit antennas.

Recommended frequency assignments for both transmit and broadband biconical receive antennas are shown in Figure 2. This is an ideal solution since each receive antenna covers the harmonics from each transmitting antenna. Since there is no need to switch in additional antennas, this is a rather simple solution. While not as elegant as a single receive antenna, it is the next best thing and quite amenable to control via software.

In the event that a single receive antenna were not available to respond to the 3rd harmonic of each transmitting antenna, one could opt for a less desirable, overlapping approach as shown in Figure 3. This setup is commercially available by combining a Biconical Log-Periodic with a double-ridge antenna. It can be seen that the lower frequency transmit antenna requires both the receive antennas to adequately cover all the harmonics. This is a much more difficult setup to implement either manually or via software control.

Procedure

1. Setup test as shown in Figure 4
2. Begin the test at the lowest frequency point and adjust the output of the power amplifier to generate the required test level. The test level used to measure harmonics must replicate the actual level used for EMC testing. Since IEC 61000-4-3 calls for 80% amplitude modulation, adjust the level to 18V/m CW or 10V/m with 80% amplitude modulation. By doing so, the additional power required to provide the modulation is accounted for and the resultant effect on harmonic levels is produced.
3. Measure the fundamental field level as well as the 2nd and 3rd harmonics with the receive antenna. Higher level

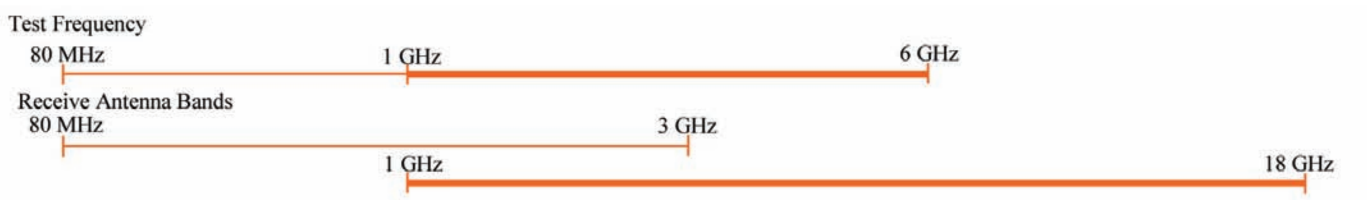


Figure 2

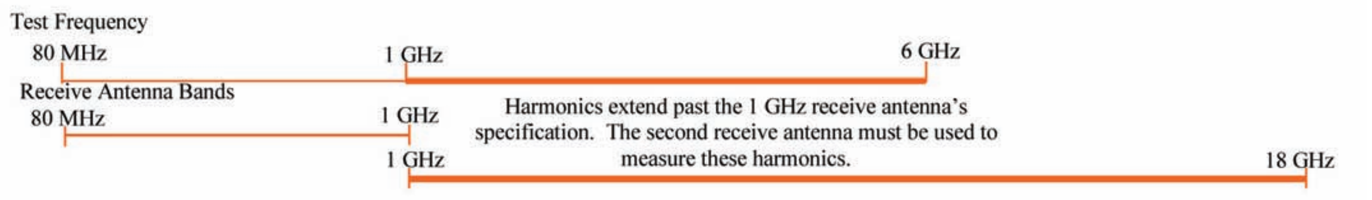


Figure 3

harmonics are generally not a problem and do not require measurement.

4. Correct readings by applying the receiving antenna's calibration factors and adjust readings to account for all cable losses.

5. Calculate the relative level (dBc) for each harmonic, where dBc = harmonic level – fundamental level.

6. Step to the next test frequency according to the test standard and repeat 1 through 5.
   a. If it appears that the harmonic measurements are high enough to require the use of a higher frequency receive antenna, in the interest of time hold off on switching out the receive antenna. Continue testing and take all measurements possible. At the completion of the test, switch to a higher frequency receive antenna and run the test again to fill in the missing harmonic measurements.
   b. If amplifier harmonics trail off significantly as measurements are taken at higher test frequencies AND the amplifier is not being driven close to saturation, testing can be halted and it can be assumed that the rest of the harmonics will be within required levels.

7. Setup for the next amplifier band and repeat the above steps.

DIRECTIONAL COUPLER/S METHOD

The Directional coupler method can also be used to measure system level harmonics. This approach is more complex than the receive antenna method and given the following inherent uncertainties, it is the least desirable choice.

- The transmit antenna is usually not calibrated. Since the manufacturers test data is not specific to the actual transmit antenna used, relying on vender supplied "typical" data for the antenna gain results in error.
- The out of band performance of the transmit antenna where harmonics are present is usually unknown.
- The harmonic test may require additional directional couplers than used during the actual EMC test causing small changes and disruption to the calibrated test setup.
- Calibration of the coupled ports of the directional coupler might be required.

Based on an assumption that harmonics should fall off at the top end of the amplifier band and not reappear at points outside the band of the amplifier, one can limit the extent of measurements taken. However, tests should be run to backup any assumptions made.

Required Equipment

- Spectrum analyzer 80MHz – 18GHz
- Directional coupler used during test
- Any additional directional couplers for higher frequency measurements
- Coax cables calibrated for losses
- Optional: Control software

Selection of equipment

In addition to the considerations noted with the receive antenna method covered above, additional directional couplers must be compatible with the power amplifier in terms of power handling capability as well as frequency range.

Procedure

1. Setup test as shown in Figure 5

2. Begin the test at the lowest frequency point and adjust the output of the power amplifier to generate the required test level. The test level used to measure harmonics must replicate the actual level used for EMC testing. Since IEC 61000-4-3 calls for 80% amplitude modulation, adjust

the level to 18V/m CW or 10V/m with 80% amplitude modulation. By doing so, the additional power required to provide the modulation is accounted for and the resultant effect on harmonic levels is produced.

3. Measure the fundamental field level as well as the 2nd and 3rd harmonics using the directional coupler. Higher level harmonics are generally not a problem and do not require measurement.

4. Correct readings by applying the directional coupler's calibrated coupling factors and adjust readings to account for all cable losses.

5. Apply the transmitting antenna's gain to the readings.
   a. If the harmonic level is outside the known gain of the antenna, use the last know value. Estimating the unknown gain can contribute significant error to the results.

6. Calculate the relative level (dBc) for each harmonic, where dBc = harmonic level – fundamental level

7. Step to next test frequency according to the test standard and repeat 1 through 6.
   a. If it appears that the harmonic measurements are high enough to require the use of a higher frequency directional coupler, in the interest of time hold off on switching out the directional coupler. Continue testing the frequencies and take all measurements possible. At the completion of the test, add in the higher frequency directional coupler and run the test again to fill in the missing harmonic measurements.
   b. If amplifier harmonics trail off significantly as measurements are taken at higher test frequencies AND the amplifier is not being driven close to saturation, testing can be halted and it can be assumed that the rest of the harmonics will be within required levels.

8. Setup for the next amplifier band and repeat the above steps.

Note: Care should be taken that if an additional directional coupler is used it does not add significant losses to the test system. ■

Pat Malloy *has been the sales application engineer at Amplifier Research, now AR, since 1987. Previous work experience includes four years with the U.S. Navy as a guided-missile electronic technician, seven years in an engineering group at AT&T Bell Laboratories, and 16 years as a senior sales engineer for Tektronix. He graduated from Lafayette College in 1972 with a B.S.E.E. Mr. Malloy can be reached at pmalloy@ar-worldwide.com.*

Jason Smith *has been the applications engineering manager at AR since 2004. Previous work experience includes test engineer and EMC lab manager at Radiation Systems and EMC lab manager at Analalb, LLC. Jason has over 10 years experience in EMC testing experience with military, avionics, commercial, medical, telecom and automotive applications. He is a member of the USNC to SC77B and SC77C and a participating member of WG10 (IEC 61000-4-3, -6). He graduated from the University of Delaware in 1997 with a B.S. in Engineering Technology. Mr Smith can be reached at jsmith@ar-worldwide.com.*

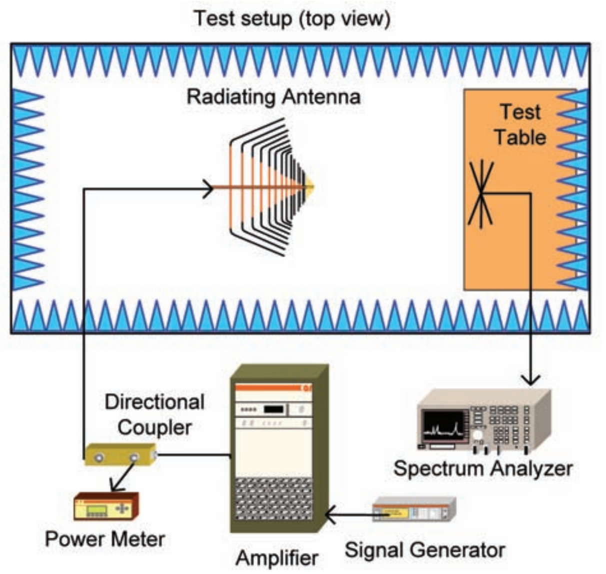


Figure 4: Basic Setup Diagram for Receive Antenna

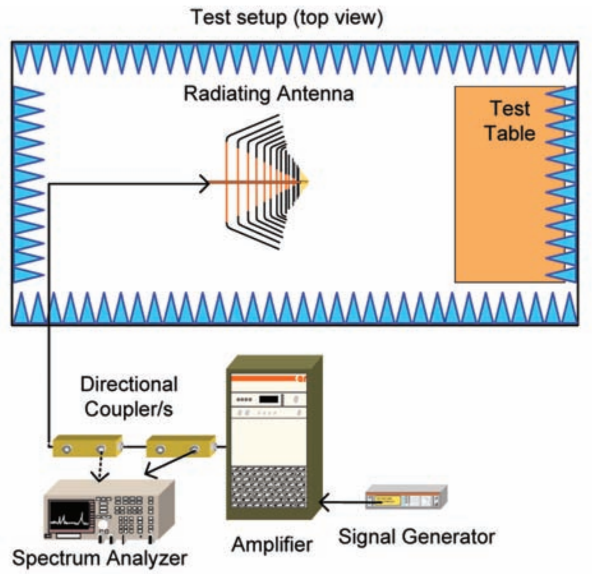
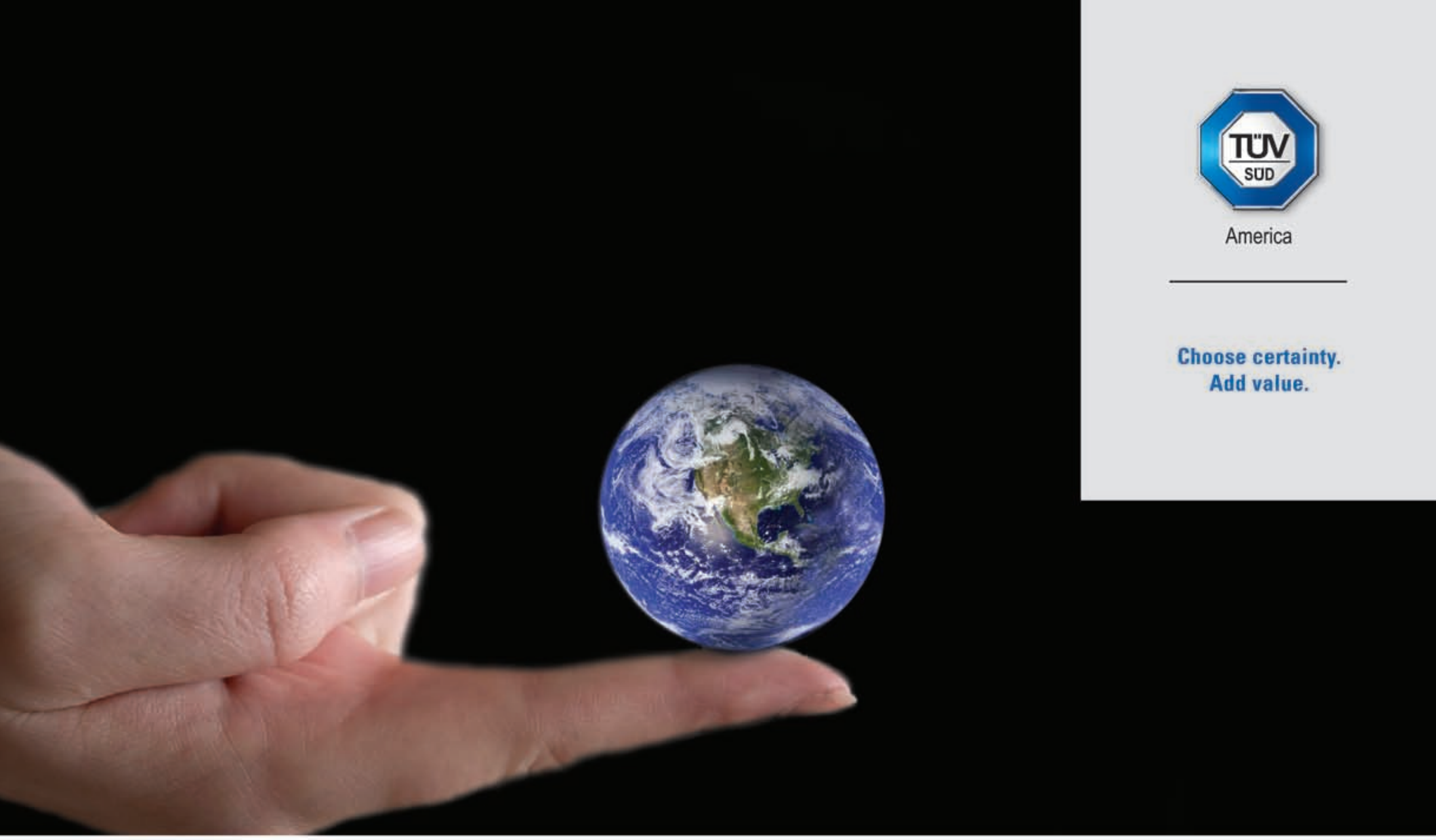


Figure 5: Basic Setup Diagram for Directional Coupler



MIL-STD-464B

A Review of the Latest Revisions to the Standard

Part 1

by Ken Javor, EMC Compliance

LATE-BREAKING NEWS UPDATE!

Due to problems in the digital publishing process, MIL-STD-464B 01 October 2010 is scrapped and MIL-STD-464C, release date 01 December 2010 will take its place. There are no technical changes from what are described in this three part article, but the replacement for MIL-STD-464A will be MIL-STD-464C. MIL-STD-464B dated 01 October 2010 will cease to exist.

As you read this article, MIL-STD-464B, "Electromagnetic Environmental Effects Requirements for Systems" is newly minted with an official release date likely to be 01 October 2010.

MIL-STD-464 is the DoD top-level E3 requirement set for procurement of complete or modified systems. "Systems" meaning an integrated platform of one type or another, such as a ground or air vehicle, a ship or submarine, a spacecraft or launch vehicle. Note that some systems can be parts of other systems, such as an F-18 fighter aircraft that operates from an aircraft carrier.

MIL-STD-464B is the latest in a long line of standards that goes back to at least MIL-I-6051, "Interference Limits and Methods of Measurement; Aircraft Radio and Electronic Installations," released in 1950. The -6051 series culminated in MIL-E-6051D, "Electromagnetic Compatibility Requirements, Systems," released in 1967 and used until MIL-STD-464 replaced it in 1997.

The A & B revisions of MIL-STD-464 amend the original release but are evolutionary, not revolutionary changes. MIL-STD-464B has many changes, so many that the new Section 6.8, "Changes from Previous Issue" states, "Marginal notations are not used in the revision to identify changes with respect to the previous issue due to the extensiveness of the changes." However, there are no major departures from MIL-STD-464A. There are some additional requirements and changes to environment definitions, but the overall standard has the same look and feel, and if readers have worked with MIL-STD-464A, they will be right at home with the "B" revision. In fact, the changes are subtle and buried enough that the point of this review is to flag things that might not leap out at the reader at first glance. This review functions as the non-existent "marginal notations."

Aside from the contractual aspect of being the E3 discipline procurement standard, the appendix of MIL-STD-464B continues to be where the really good lessons-learned type information may be found. The appendix has been significantly revised. For each main body change identified in the article, the reader is well-advised to seek out the corresponding Appendix section(s).

Fair Warning: What follows is intended to be a comprehensive aid to the user. Making this list a "page-turner" was well beyond the author's meager capabilities. So, with no further ado, and coffee cups filled, we wade in.

A very user-friendly feature, non-content-related, is that the table of contents is hyperlinked to the various sections of the document. An electronic copy of the standard is more desirable than ever.

A very user-friendly feature, non-content-related, is that the table of contents is hyperlinked to the various sections of the document. An electronic copy of the standard is more desirable than ever. There is no hyperlink between main body and appendix material yet – leaving the user community something to look forward to in revisions yet to come…

The major additions to this revision of the standard are the high power microwave (HPM) requirement and the new requirement on unintentional emissions, about which more later. The HPM requirement is described at an unclassified level, in keeping with the unlimited distribution status of MIL-STD-464. The HPM environment presented in the appendix represents known threats, not what might exist at some time in the future "if present trends continue." A second addition is a requirement levied to limit interference from co-located Army systems. The scenario that prompted this new requirement is the side-by-side juxtaposition of systems not previously expected to operate side-by-side, such as a ground vehicle parked immediately adjacent to a Tactical Operations Center (TOC) antenna installation, or perhaps two different vehicles very close to each other in a convoy. The requirement is that placement of the culprit-victim pair of systems at one meter separation not cause unacceptable degradation to each other's communication abilities. The requirement is verified by bringing antennas of the sort used by the victim platform within one meter of the culprit and measuring the antenna output with an appropriate spectrum analyzer or EMI receiver for comparison to the victim radio's noise floor. The requirement verification is borrowed from the spectrum analyzer technique already used in MIL-STD-464 for verifying the compatibility of radio and antenna installations on the same platform.

And now, a section-by-section summary of changes. Only changed sections are listed. In the list that follows, the bold section number is for MIL-STD-464B. If the section number is the same as it was for MIL-STD-464A, then it only appears once. If the number is different, then the -464A number appears after it in parentheses.

Section 2.2.1 in the applicable documents section adds MIL-STD-1605(SH), Procedures for Conducting a Shipboard Electromagnetic Interference (EMI) Survey (Surface Ships)

Section 2.2.2 in the applicable documents section adds an HPM-related Intel report: "Information Operations Capstone Threat Assessment Report (Latest Edition)"

Section 3 is definitions. This first installment includes all the new or changed definitions in Section 3.
The next installment will continue on with Section 4, General Requirements, and Section 5, Detailed Requirements."

(Section 3.1) The MIL-STD-464A definition "Above Deck: An area on ships, which is directly exposed to the external electromagnetic environment, and is not considered to be below deck as defined herein," is replaced by the more general **Section 3.27** "Topside Area" definition in Section 3.27: "All shipboard areas continuously exposed to the external electromagnetic environment, such as the main deck and above, catwalks, and those exposed portions of gallery decks."

Section 3.4 (3.5) The definition of Electromagnetic Environmental Effects is expanded to include electronic protection, HPM, and ultra-wideband devices.

Section 3.5 is new: a definition for HERO Safe Ordnance: "Any ordnance item that is sufficiently shielded or otherwise so protected that all electrically initiated devices (EIDs) contained by the item are immune to adverse effects (safety or reliability) when the item is employed in the radio frequency environment delineated in MIL-STD-464. The general hazards of electromagnetic radiation to ordnance requirements defined in the hazards from electromagnetic radiation manuals must still be observed. Note: Percussion-initiated ordnance have no HERO requirements.

Section 3.6 is new: a definition for HERO Susceptible Ordnance: "Any ordnance item containing electro-explosive devices proven by test or analysis to be adversely affected by radio frequency energy to the point that the safety and/or reliability of the system is in jeopardy when the system is employed in the radio frequency environment delineated in MIL-STD-464.

Section 3.7 is new: a definition for HERO Unsafe Ordnance: "Any ordnance item containing electrically initiated devices that have not been classified as HERO SAFE or HERO SUSCEPTIBLE ordnance as a result of a hazard of electromagnetic radiation to ordnance (HERO) analysis or test. Additionally, any ordnance item containing electrically initiated devices (including those previously classified as HERO SAFE or HERO SUSCEPTIBLE ordnance) that has its internal wiring exposed; when tests are being conducted on that item that result in additional electrical connections to the item; when electrically initiated devices having exposed wire leads are present and handled or loaded in any but the tested condition; when the item is being assembled or disassembled; or when such ordnance items are damaged causing exposure of internal wiring or components or destroying engineered HERO protective devices."

Section 3.8 is new: a definition for HPM: "A radio frequency environment produced by microwave sources (weapon) capable of emitting high power or high energy densities. The HPM operating frequencies are typically between 100 MHz and 35 GHz, but may include other frequencies as technology evolves. The source may produce microwaves in the form of a single pulse, repetitive pulses, pulses of more complex modulation, or continuous wave (CW) emissions."

Section 3.18 is new: a definition for platform: " A mobile or fixed installation such as a ship, aircraft, ground vehicles and shelters, launch-space vehicles, shore or ground station. For the purposes of this standard, a platform is considered a system."

Section 3.19 (3.15) adds a sentence at the end of the definition of Safety Critical: "A term also used when a failure or malfunction of a system or subsystem can cause death or serious injury to personnel."

Section 3.20 is new: a definition for Shielded Area: "An area not directly exposed to EM energy. This includes shielded spaces, compartments and rooms; areas inside the hull and superstructure of metallic hull ships; areas inside metallic shelters, a metallic enclosure or a metallic mast; and areas in screen rooms on nonmetallic hull ships."

Section 3.21 is new: a definition for Spectrum-dependent systems: "All electronic systems, subsystems, devices, and/or equipment that depend on the use of the spectrum to properly accomplish their function(s) without regard to how they were acquired (full acquisition, rapid acquisition, Joint Concept Technology Demonstration, etc.) or procured (commercial off-the-shelf, government off-the-shelf, non-developmental items, etc.).

Section 3.23 is new: a definition for Subsystem: "A portion of a system containing two or more integrated components that, while not completely performing the specific function of a system, may be isolated for design, test, or maintenance. Either of the following are considered subsystems for the purpose of establishing EMC requirements. In either case, the devices or equipments may be physically separated when in operation and will be installed in fixed or mobile stations, vehicles, or systems.

a. A collection of devices or equipments designed and integrated to function as a single entity but wherein no device or equipment is required to function as an individual device or equipment.

b. A collection of equipment and subsystems designed and integrated to function as a major subdivision of a system and to perform an operational function or functions. Some activities consider these collections as systems; however, as noted above, they will be considered as subsystems.

Section 3.24 is new: a definition for System: "A composite of equipment, subsystems, skilled personnel, and techniques capable of performing or supporting a defined operational role. A complete system includes related facilities, equipment, subsystems, materials, services, and personnel required for its operation to the degree that it can be considered self-sufficient within its operational or support environment. See 3.18."

Ken Javor *has worked in the EMC industry for thirty years. He is a consultant to government and industry, runs a pre-compliance EMI test facility, and curates the Museum of EMC Antiquities, a collection of radios and instruments that were important in the development of the discipline, as well as a library of important documentation. Mr. Javor is an industry representative to the Tri-Service Working Groups that write MIL-STD-464 and MIL-STD-461. He has published numerous papers and is the author of a handbook on EMI requirements and test methods. Mr. Javor can be contacted at ken.javor@emccompliance.com*

Fundamentals of Electrostatic Discharge

Part *5*: Device Sensitivity and Testing

by the ESD Association

In Part 2 of this series we indicated that a key element in a successful static control program was the identification of those items (components, assemblies and finished products) that are sensitive to ESD and the level of their sensitivity. Damage to an ESDS device by the ESD event is determined by the device's ability to dissipate the energy of the discharge or withstand the current levels involved. This is known as device "ESD sensitivity" or "ESD susceptibility."

Some devices may be more readily damaged by discharges occurring within automated equipment, while others may be more prone to damage from handling by personnel. In this article we will cover the models and test procedures used to characterize, determine and classify the sensitivity of components to ESD. These test procedures are based on the two primary models of ESD events: Human Body Model (HBM) and Charged Device Model (CDM). The models used to perform component testing cannot replicate the full spectrum of all possible ESD events. Nevertheless, these models have been proven to be successful in reproducing over 99% of all ESD field failure signatures. With the use of standardized test procedures, the industry can:

- Develop and measure suitable on-chip protection.
- Enable comparisons to be made between devices.
- Provide a system of ESD sensitivity classification to assist in the ESD design and monitoring requirements of the manufacturing and assembly environments.
- Have documented test procedures to ensure reliable and repeatable results.

HUMAN BODY MODEL (HBM) TESTING

One of the most common causes of electrostatic damage is the direct transfer of electrostatic charge through a significant series resistor from the human body or from a charged material to the electrostatic discharge sensitive (ESDS) device. When one walks across a floor, an electrostatic charge accumulates on the body. Simple contact of a finger to the leads of an ESDS device or assembly allows the body to discharge, possibly causing device damage. The model used to simulate this event is the Human Body Model (HBM).

The Human Body Model is the oldest and most commonly used model for classifying device sensitivity to ESD. The HBM testing model represents the discharge from the fingertip of a standing individual delivered to the device. It is modeled by a 100 pF capacitor discharged through a switching component and a 1.5kΩ series resistor into the component. This model, which dates from the nineteenth century, was developed for investigating explosions of gas mixtures in mines. It was adopted by the military in MIL-STD-883 Method 3015 and is referenced in *ANSI/ESDA-JEDEC JS-001-2010: Electrostatic Discharge Sensitivity Testing - Human Body Model*. This document replaces the previous ESDA and JEDEC methods, STM5.1-2007 and JESD22-A114F respectively. A typical Human Body Model circuit is presented in Figure 1.

Testing for HBM sensitivity is typically performed using automated test systems. The device is placed in the test system and contacted through a relay matrix. ESD zaps are applied. A part is determined to have failed if it does not meet the datasheet parameters using parametric and functional testing.

CHARGED DEVICE MODEL (CDM) TESTING

The transfer of charge *from* an ESDS device is also an ESD event. A device may become charged, for example, from sliding down the feeder in an automated assembler. If it then contacts the insertion head or another conductive surface, which is at a lower potential, a rapid discharge may occur from the device to the metal object. This event is known as the Charged Device Model (CDM) event and can be more destructive than the HBM for some devices. Although the duration of the discharge is very short - often less than one nanosecond - the peak current can reach several tens of amperes.

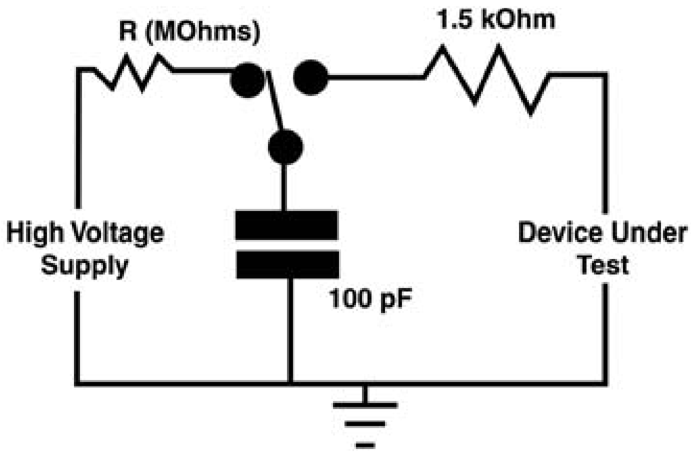


Figure 1: Typical Human Body Model Circuit

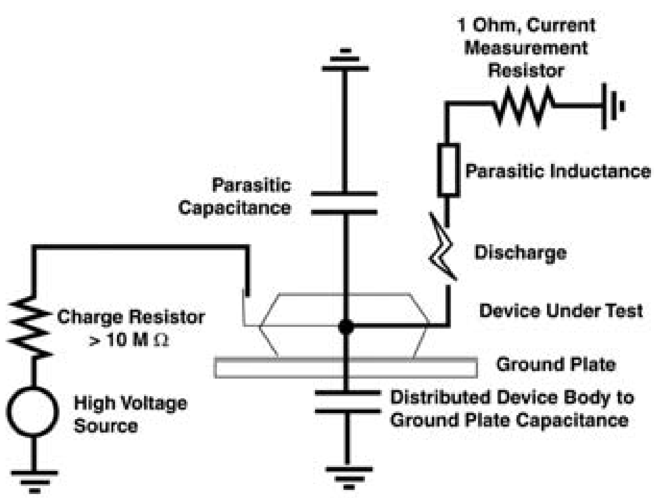


Figure 2: Typical Charged Device Model Test

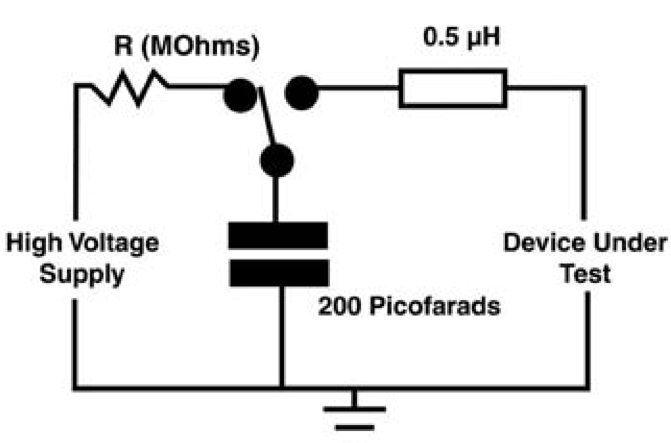


Figure 3: Typical Machine Model Circuit

The device testing standard for CDM *(ESD STM5.3.1: Electrostatic Discharge Sensitivity Testing - Charged Device Model)* was originally published in 1999. The test procedure involves placing the device on a field plate with its leads pointing up, then charging it and discharging the device. Figure 2 illustrates a typical CDM test circuit. The CDM 5.3.1 ESDA document was last published in 2009.

OTHER TEST METHODS

Machine Model (MM) Testing

A discharge which is different in shape and size to the HBM event also can occur from a charged conductive object, such as a metallic tool or an automatic equipment or fixture. Originating in Japan as the result of trying to create a worst-case HBM event, the model is known as the Machine Model. This ESD model consists of a 200 pF capacitor discharged directly into a component with no series DC resistor in the output circuitry. The industry is in the process of removing this model from qualification requirements. The technical background on this change is described in Industry Council White Paper 1, "A Case for Lowering Component Level HBM/MM ESD Specifications and Requirements."

As a worst-case human body model, the Machine Model may be over severe. However, there are real-world situations that this model may simulate, for example the rapid discharge from the metallic contacts on a charged board assembly or from the charged cables or handles/ arms of an automatic tester.

Testing of devices for MM sensitivity using ESD Association standard *ESD STM5.2: Electrostatic Discharge Sensitivity Testing - Machine Model* is similar in procedure to HBM testing. The test equipment is the same, but the test head is slightly different. The MM version does not have a 1,500 ohm resistor, but otherwise the test board and the socket are the same as for HBM testing. The series inductance, as shown in Figure 3, is the dominating parasitic element that shapes the oscillating machine model wave form. The series inductance is indirectly defined through the specification of various waveform parameters like peak currents, rise times and the period of the waveform. The MM 5.2 document was last published in 2009.

Socketed Device Model (SDM) Testing

SDM testing is similar to testing for HBM and MM sensitivity. The device is placed in a socket, charged from a high-voltage source and then discharged. This model was originally intended to provide an efficient way to do CDM testing. However, the model did not have sufficient correlation with the CDM standard and there was too great a dependency on the specific design of the SDM tester. A Standard Practice (SP) document, SDM-5.3.2, was first published in 2002 and re-published in 2008. A technical report, *ESD TR5.3.2 (formerly TR08-00): Socket Device Model (SDM) Tester* is also available from the ESD Association.

DEVICE SENSITIVITY CLASSIFICATION

The HBM and CDM methods include a classification system for defining the component sensitivity to the specified model (See Tables 1 and 2). These classification systems have a number of advantages. They allow easy grouping and comparing of components according to their ESD sensitivity and the classification gives you an indication of the level of ESD protection that is required for the component.

A fully characterized component should be classified using Human Body Model and Charged Device Model. For example, a fully characterized component may have 2 of the following: Class 1B (500 volts to <1000 volts HBM) and Class C3 (500 volts to <1000 volts CDM). This would alert

Class	Voltage Range
Class 0	<250 volts
Class 1A	250 volts to <500 volts
Class 1B	500 volts to < 1,000 volts
Class 1C	1000 volts to < 2,000 volts
Class 2	2000 volts to < 4,000 volts
Class 3A	4000 volts to < 8000 volts
Class 3B	≥ 8000 volts

Table 1: ESDS Component Sensitivity Classification - Human Body Model (Per ESD STM5.1-2007)

Class	Voltage Range
Class C1	<125 volts
Class C2	125 volts to <250 volts
Class C3	250 volts to <500 volts
Class C4	500 volts to <1,000 volts
Class C5	1,000 volts to <1,500 volts
Class C6	1,500 volts to <2,000 volts
Class C7	≥ 2,000 volts

Table 2: ESDS Component Sensitivity Classification - Charged Device Model (Per ESD STM5.3.1-2009)

> ***Device failure models and device test methods define the sensitivity of the electronic devices and assemblies to be protected from the effects of ESD.***

a potential user of the component to the need for a controlled environment, whether assembly and manufacturing operations are performed by human beings or machines.

A word of caution; however, these classification systems and component sensitivity test results function as guides, not necessarily as absolutes. The events defined by the test data produce narrowly restrictive data that must be carefully considered and judiciously used. The two ESD models represent discrete points used in an attempt to characterize ESD vulnerability. The data points are informative and useful, but to arbitrarily extrapolate the data into a real world scenario can be misleading. The true utility of the data is in comparing one device with another and to provide a starting point for developing your ESD control programs.

SUMMARY

Device failure models and device test methods define the sensitivity of the electronic devices and assemblies to be protected from the effects of ESD. With this key information, you can design more effective ESD control programs.

FOR FURTHER REFERENCE

- *ESD STM5.1-2007: Electrostatic Discharge Sensitivity Testing - Human Body Model,* ESD Association, Rome, NY.
- *ESD STM5.2-2009: Electrostatic Discharge Sensitivity Testing - Machine Model,* ESD Association, Rome, NY.
- *ESD STM5.3.1-2009: Electrostatic Discharge Sensitivity Testing - Charged Device Model,* ESD Association, Rome, NY.
- *ESD TR 5.3.2- (formerly TR08-00): Socket Device Model (SDM) Tester,* ESD Association, Rome, NY.
- ESD Industry Council White Paper 1: "A Case for Lowering Component Level HBM/MM ESD Specifications and Requirements," August 2008, http://www.esda.org/IndustryCouncil.html.
- ESD Industry Council White Paper 2: "A Case for Lowering Component Level CDM ESD Specifications and Requirements," March 2009, http://www.esda.org/IndustryCouncil.html.
- "A Closer Look at the Human ESD Event," Hyatt, Hugh, et al, *EOS/ESD Symposium Proceedings,* 1981, ESD Association, Rome, NY.
- "Charged Device Model Testing: Trying to Duplicate Reality," Avery, L.R., *EOS/ESD Symposium Proceedings,* 1987, ESD Association, Rome, NY.
- "Critical Issues Regarding ESD Sensitivity Classification Testing," Pierce, Donald C., *EOS/ESD Symposium Proceedings,* 1987, ESD Association, Rome, NY.
- "Beyond MIL HBM Testing - How to Evaluate the Real Capability of Protection Structures, Avery, L.R., *EOS/ESD Symposium Proceedings,* 1991, ESD Association, Rome, NY.
- "Mechanisms of Charged-Device Electrostatic Discharges," Renninger, Robert G., *EOS/ESD Symposium Proceedings,* 1991, ESD Association, Rome, NY.
- "Analysis of HBM ESD Testers and Specifications Using a 4th Order Lumped Element Model," Verhaege, Koen, et al, *EOS/ESD Symposium Proceedings,* 1993, ESD Association, Rome, NY.
- "A Comparison of Electrostatic Discharge Models and Failure Signatures for CMOS Integrated Circuit Devices," Kelly, M., et al, *EOS/ESD Symposium Proceedings,* 1995, ESD Association, Rome, NY.
- "Study of ESD Evaluation Methods for Charged Device Model," Wada, Tetsuaki, *EOS/ESD Symposium Proceedings,* 1995, ESD Association, Rome, NY.
- "A Compact Model for the Grounded-Gate nMOS Behavior Under CDM ESD Stress," Russ, Christian, et al, *EOS/ESD Symposium Proceedings,* 1996, ESD Association, Rome, NY.
- "Recommendations to Further Improvements of HBM ESD Component Level Test Specifications," Verhaege, Koen, et al, *EOS/ESD Symposium Proceedings,* 1996, ESD Association, Rome, NY.
- "Very Fast Transmission Line Pulsing of Integrated Structures and the Charged Device Model," Gieser, H., and Haunschild, M., *EOS/ESD Symposium Proceedings,* 1996, ESD Association, Rome, NY.
- "Investigation into Socketed CDM (SDM) Tester Parasitics," Chaine, M., et al, *EOS/ESD Symposium Proceedings,* 1998, ESD Association, Rome, NY.
- "Issues Concerning CDM ESD Verification Modules - The Need to Move to Alumina," Henry, L.G., et al, *EOS/ESD Symposium Proceedings,* 1999, ESD Association, Rome, NY.
- "The Importance of Standardizing CDM ESD Test Head Parameters to Obtain Data Correlation," Henry, L.G., et al, *EOS/ESD Symposium Proceedings,* 2000, ESD Association, Rome, NY.
- "Component Level ESD Testing," Review Paper, Verhaege, Koen, *Microelectronics Reliability Journal*, 1998.


It's SHOCKING...How Affordable In-House Product Safety Testing Can Be!
Leakage Current Testers
Finger Probes
Impact Hammers
Hipot Testers
Force Gauges
Glow Wire Testers
Save Time... Save Money... Get Smart...
ED&D is the world's leading source for precision product safety test equipment. Our on-staff engineers are the most highly qualified in the industry. Let us show you how to speed your products to market... We know saving you even two extra weeks in the regulatory process can mean the difference between profit and loss. Test in advance to be sure you will pass the first time!
Buy Direct From Our Web Site!
NORDIC COUNTRIES
IC DOC
TÜV
MET
PORTABLE FORCE INDICATOR PFI-200N
HP 2000
Your One-Stop Product Safety Shop – Everything You Need for Product Safety!
ED&D
Educated Design & Development, Inc.
901 Sheldon Dr., RTP (Cary), NC 27513 USA
Toll Free: (800) 806-6236 Fax: (919) 469-5743
Visit Our Web Site – http://www.ProductSafeT.com

Are Standards Still Important?

Even More So in the Global Economy

by Fred Tenzer, Vice-Chair ESDA STDCOM

Standards are increasingly important in our modern global economy – supply chains can be dizzyingly complex, and implementing the economic theory of comparative advantage has been more and more possible as the relative cost of transportation has declined over the years. Since the 1890s, the United States has been the world's top manufacturing country. The world continues to change. Recently it was reported that China surpassed Japan as the second largest economy, and it is estimated that China will soon surpass the United States.

What does "Made in China" mean? Or for that matter, "Made in America?" *The Wall Street Journal* recently published an article about a premium computer mouse with the label "Made in China." The article detailed the global supply chain effort to efficiently bring all components to assemble the mouse together. The logistics were complex and quite impressive. The two highest value components, an integrated chip and the optics, were manufactured in the United States. The plastic parts were molded and the mouse assembled in China. Globalization has produced a plethora of goods at attractive pricing, a modern miracle.

How do all the various manufacturers, customers and suppliers communicate to have meaningful metrics from facility to facility around the world? Industry Standards play a major role in ensuring that what is designed in one place can be built in another. For instance, in manufacturing, having uniform quality requirements and testing procedures is necessary to make sure that all involved parties are speaking the same language. In ESD control programs, standard test methods have been developed for component ESD test models to measure a component's sensitivity to electrostatic discharge from various sources. Standard test methods for product qualification and periodic evaluation of wrist straps, garments, ionizers, worksurfaces, grounding, flooring, shoes, static dissipative planar materials, shielding bags, packaging, electrical soldering/desoldering hand tools and flooring/footwear systems have been developed to ensure uniformity around the world.

The ESD Association (ESDA) is dedicated to advancing the theory and practice of ElectroStatic Discharge (ESD) avoidance. The ESD Association is an American National Standards Institute (ANSI) accredited standards developer. The ESD Association's consensus body is called the Standards Committee (STDCOM) which has responsibility for the overall development of an array of documents. Volunteers from the industry participate in working groups to develop new and update current ESDA documents. The ESD Association document categories are:

- **Standard (S):** A precise statement of a set of requirements to be satisfied by a material, product, system or process that also specifies the procedures for determining whether each of the requirements is satisfied.
- **Standard Test Method (STM):** A definitive procedure for the identification, measurement and evaluation of one or more qualities, characteristics or properties of a material, product, system or process that yield a reproducible test result.
- **Standard Practice (SP):** A procedure for performing one or more operations or functions that may or may not yield a test result. Note, if a test result is obtained, it is not reproducible.
- **Technical Report (TR):** A collection of technical data or test results published as an informational reference on a specific material, product, system or process.

The standard covering the requirements for creating and managing an ESD control program is *ANSI/ESD S20.20: ESD Association Standard For the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)*. ANSI/ESD S20.20 is a commercial update of MIL-STD-1686 and has been adopted by the United States Department of Defense. In addition, the 2007-2008 update of *IEC 61340-5-1 Edition 1.0: Electrostatics - Part 5-1: Protection of Electronic Devices from Electrostatic Phenomena General Requirements* is technically equivalent to ANSI/ESD S20.20. According to Ryne Allen's 1999 article, "The [S20.20] standard was initiated under the guidance of the late Joel P. Weidendorf of IBM when he was chairman of the ESD Association Standards Committee. It went through 18 versions before the final approval by the ESD Association and then was reviewed and approved by the American National Standards Institute."

In order to meet the global need in the electronics industry for technically sound ESD Control Programs, the ESD Association has established an independent third party certification program. The program is administered by the ESD Association through country-accredited ISO 9000 Certification Bodies that have met the requirements of this program. The Facility Certification Program evaluates a facility's ESD program to ensure that the basic requirements from industry standards ANSI/ESD S20.20 or IEC 61340-5-1 are being followed. There are currently more than 180 facilities certified worldwide.

Global competitiveness is facilitated by promoting and using voluntary consensus standards and conformity assessment systems. Does it work? The improving complexity, value and reliability of products containing electronics would indicate that the answer is a resounding "Yes." Standards greatly enhance the ability to understand and communicate technical requirements around the world. ■

A complete list of all ESD Association published documents can be found at http://www.esda.org/standards.html. In addition, the ESD Association offers a selection of complimentary key download documents, including ANSI/ESD S20.20 in English, traditional Chinese, simplified Chinese, Japanese, Spanish and Thai. Other complimentary key download documents available include *ANSI/ESD S541 - Packaging Materials for ESD Sensitive Items*, *ESD ADV1.0 - ESD Association Glossary of Terms*, ESD awareness symbols and a select number of Device Testing standards.

REFERENCES

- ESD Association: www.ESDA.org
- American National Standards Institute: www.ANSI.org
- White paper by Ryne Allen: ESDSystems.com

Fred Tenzer *is the National Sales Manager for the Desco Brand of Desco Industries, Inc. He is a founding member of the ESD Association (ESDA) and a member of ESDA's Standards Development since 1982. Fred is currently Vice-Chair for ESDA's Standards Committee & Chair of the Standards Staff/Technology & Administrative Support for all Standards Working Groups on Standards Development.*

The Future of EMC Engineering

by Mark I. Montrose, Montrose Compliance Services, Inc.

EMC versus Compliance Engineering

When we mention the acronym EMC, or electromagnetic compatibility, we generally think about how to ensure products comply with regulatory requirements mandated by an entity, be it a government agency, a private certification organization or voluntarily/industry-driven requirements. Why do compliance engineers always seek that elusive 3 dB? Is it because a published standard considers this level appropriate for certain environments of use? Is this limit realistic for, for example, an MP3 player used within an industrial environment? Does violating a Class A or B specification by a few dBs mean the system is an electromagnetic hazard? Will authorities having jurisdiction take the time, money and effort to prosecute companies for non-compliance over a few dBs? Does the general public know about the need for EMC, and most importantly, do they care?

Should we focus on meeting a specification or ensuring "electromagnetic compatibility?" Think about products to be designed in the future and their use. Should radiated emissions be more of a concern than immunity? EMC ensures electrical systems are compatible when used within a certain environment. For future technologies, emissions become not the concern but immunity.

Technology of the future includes the Smart Grid, Broadband over Power Line (BPL), Photovoltaics, Global Earth Observation System (GEOS), advances in health care, nanotechnology products and their applications, ultra high-frequency communication networks, intelligent transportation system, along with other products that have exemption from regulatory compliance mandates (why do exemptions exist?). With technological advances on the horizon, our focus as EMC engineers should be to ensure products are designed to survive high levels of immunity to maintain reliability and quality.

What will occur when everyone with a hand phone containing multiple wireless features talk at the same time? Is undesired EMI now a concern according to a standard? However, if a strong RF signal from a high-power transmitter nearby is present, all devices could become non-operational. The same for power generation and distribution systems related to the Smart Grid. We should not worry about radiated EMI generated from the grid but preventing EMI threats from shutting down the network. How about ensuring medical systems are robust against high intensity RF fields in a hospital environment? Transportation systems must be 100% reliable when traveling anywhere in the world

Therefore, in the future, should one work as an EMC engineer by definition for products operated in an RF rich broadband wireless world or as a compliance engineer with a focus on achieving that 3 dB margin to a generic specification?

Mark I. Montrose *is an EMC consultant with Montrose Compliance Services, Inc. having 30 years of applied EMC experience. He currently sits on the Board of Directors of the IEEE (Division VI Director) and is a long term past member of the IEEE EMC Society Board of Directors as well as Champion and first President of the IEEE Product Safety Engineering Society. He provides professional consulting and training seminars worldwide and can be reached at mark@montrosecompliance.com*

Laboratory Announces Pre-Certification Testing Service for LTE Devices

AT4 wireless has announced the launch of its pre-certification testing service for LTE devices. By extending its laboratories' LTE expertise, AT4 wireless now offers LTE device manufacturers the ability to test against critical industry-standard or operator-specific test plans prior to submitting their devices for formal certification.

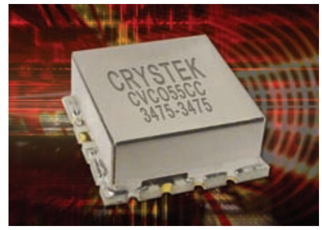
Using market-leading LTE device testing solutions developed by AT4 wireless, AT4 wireless's laboratory in Taipei, Taiwan is able to ensure that devices are thoroughly pre-tested to industry-standard requirements. A partnership with Spirent Communications also enables the laboratory to offer pre-testing to the open access and proprietary certification requirements of the leading North American operators deploying LTE. This will help to assure high levels of device quality, performance and optimization, as well as to expedite the operator device certification process.

"*These pre-testing services allow us to offer manufacturers in the Asia Pacific region the assurance that their LTE devices are ready for industry-standard certification, or for certification by leading North-American operators. Our pre-testing services will play an important role in supporting the device certification cycle; they can help with early detection of faults, speed time to market and reduce overall development costs*" said Andrés Moreno, Sales and Marketing Director at AT4 wireless.

For more information, visit www.at4wireless.com.

NEW 3475 MHz Voltage Controlled Oscillator

Crystek's CVCO55CC-3475-3475 VCO (Voltage Controlled Oscillator) operates at 3475 MHz with a control voltage range of 0.5V~4.5V. This VCO features a typical phase noise of -115 dBc/Hz @ 10KHz offset and, the company reports, has excellent linearity. Output power is typically +7 dBm.



Engineered and manufactured in the USA, the model CVCO55CC-3475-3475 is packaged in the industry-standard 0.5-in. x 0.5-in. SMD package. Input voltage is 8V, with a max. current consumption of 35 mA. Pulling and Pushing are minimized to 0.2 MHz and 0.2 MHz/V, respectively. Second harmonic suppression is -15 dBc typical.

The CVCO55CC-3475-3475 is ideal for use in applications such as digital radio equipment, fixed wireless access, satellite communications systems, and base stations.

For further information please visit www.crystek.com.

Audio Jack Detection and Configuration Switch Simplifies Designs, Reduces BOM and Saves Board Space

The traditional 3.5mm audio jack in cell phones, smartphones, MP3 and personal media players (PMPs) is still the primary way for users to connect headsets for speaking as well as headphones for listening to music. To accommodate this efficiently, designers need a device that can detect and configure the audio jack for different accessories.

Fairchild Semiconductor developed the FSA8008 audio jack detection and configuration switch as a one-chip audio jack detector and switch for 3- or 4-pole accessories. While current solutions use several discrete components (dual comparator, analog switch and MOSFET) with software control to meet this need, the FSA8008 integrates this functionality into a single device, simplifying designs, and saving up to 70% of the board space and up to 15% bill of material (BOM) costs.

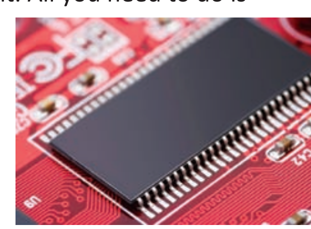
The device features 15kV (air gap) and 12kV (HBM) ESD protection, as well as 0.01 percent (typical) total harmonic distortion (MIC). The FSA8008 is available in a 10-lead UMLP package (1.4 x 1.8 x 0.5mm, 0.4mm pitch).

For more information on please visit www.fairchildsemi.com.

Self-Adhesive Cooling Patch

A new thermal material breakthrough from Fujipoly allows engineers to reduce chip and circuit temperature by as much as 11% without the need for a heatsink.

The advanced 4-ply, peel-n-stick FPDSEM 90 Cooling Patch offers the fastest and easiest way to radiate heat from an electronic component to the surrounding environment. All you need to do is apply the patch like a sticker to the surface of any "hot spot". The material can also be custom cut or trimmed to fit virtually any shape.



The low resistance Cooling Patch provides a thermal conductivity of 1.5 W/m°K and a thermal emissivity of 0.97. Fujipoly's FPDSEM 90 is 25mm thick and can be ordered in sheets, rolls or kiss-cut rolls depending on your application.

For more information, call (732) 969-0100 or visit www.fujipoly.com.

Laboratory Named "EPA Recognized Certification Body" for ENERGY STAR®

Intertek has announced that it has been named an "EPA Recognized Certification Body" (CB) for the new ENERGY STAR® Enhanced Testing and Verification procedures. Effective December 31, 2010, the new ENERGY STAR® third-party certification requirements will require manufacturers seeking use of the ENERGY STAR® label to submit products for third-party certification from EPA Recognized Certification Bodies.

Intertek is the only EPA Recognized CB which covers certification for all gas and electrical ENERGY STAR® product categories, including more than 60 product types across Appliances, Home Electronics, HVAC, Information Technology, Lighting, and Commercial Food Service Equipment.

For manufacturers requiring testing, Intertek recently deployed 18 global Energy Efficiency Centers of Excellence, throughout North America, Asia and Europe. These Energy Efficiency labs provide immediate testing capacity for qualification and verification testing, strategically located in key regional manufacturing centers. Additionally, for ENERGY STAR® Partners that will conduct testing in their own labs, as part of Intertek's SATELLITE Data Acceptance Program, Partners will submit test data to Intertek for engineering review to product specification requirements, and then ENERGY STAR® certification will be awarded for compliant products.

For more information on Intertek's Energy Efficiency capabilities or ENERGY STAR program requirements, call 1-800-WORLDLAB (967-5352) or visit www.intertek.com/energystar.

Fabric Shielding Gasket Product Line Launched

Leader Tech has announced the launch of a new Fabric Shielding Gasket product line. This introduction is marked by the publication of a dedicated FSG catalog that provides performance and application data on over 125 gasket profiles and sizes.

The light-weight, easy-to-install gaskets are ideal for most electronic enclosure shielding applications. The company's FSG products are manufactured with a resilient polyurethane foam core and a unique, highly conductive nickel/copper ripstop outer fabric.

All FSG gaskets exhibit low compression characteristics and offer a shielding effectiveness up to 18 dB.

A digital copy of the Fabric Shielding Gasket catalog is available for immediate download from the company's web site at www.leadertechinc.com. Reservations are also being accepted for the print catalog.

Automotive Solutions for Next Generation Body Electronics Applications

ON Semiconductor has announced the launch of three new products specifically targeted at the automotive market sector. All three devices support current and next generation body electronics applications.

The new NCV7321 is a fully featured local interconnect network (LIN) transceiver designed to interface between a LIN protocol controller and the physical bus in low data rate in-vehicle networking (IVN) applications. Excellent electromagnetic compatibility (EMC) coupled with robust system level electrostatic discharge (ESD) performance of up to 13 kilovolts (kV) that negates the need for external ESD components, makes the NCV7321 ideal for the typically harsh environments found in automotive applications.

The new NCV7608 is an octal configurable low-side / high-side driver. The compact AEC Q10X-12 (rev.A) qualified SOIC-28W packaged device is able to operate at junction temperatures ranging from -40 °C to +150 °C. With a wide input voltage range of 3.15 V to 5.25 V, and eight fully independent output drivers that can be configured in any combination of high-side, low-side, or half-bridge configurations, the NCV7608 offers maximum flexibility to designers tasked with driving a large number of loads.

Digital control of all output stages can be carried out through the integrated standard Serial Peripheral Interface (SPI). This also allows diagnostic fault information to be acquired. In addition, four channels can be pulse width modulation (PWM) controlled via external control input pins. The new device has a typical on state resistance (RDSON) of just 1.2 ohms (Ω), at 25 ºC, helping to significantly extend battery life.

Finally, ON Semiconductor has announced the development of the NCV786xx Power Ballast and Dual LED Driver product platform for advanced LED front lighting systems. Developed to support system level requirements for driving multiple LED strings of up to 60 V, PWM dimming to maintain LED color temperature, and controlled average current, the product platform enables designers to control high and low beams, daytime running lights, turn indicators, and fog lights with one system-on-chip device. The platform allows communication with an external microcontroller to change operating parameters after power-up, implement LED-short detection, and provide advanced system diagnostics.

The first product – the NCV78663 - will be released to market in 2011. For further information visit www.onsemi.com.

Company Achieves Accreditation for Calibration Services

Restor Metrology has become the third calibration services provider in the US to achieve accreditation to ANSI/NCSL Z540.3-2006.

According to Alan Keith, Restor Metrology's Director of Operations, "Achieving accreditation to both ISO/IEC 17025 and ANSI/NCSL Z540.3-2006 is the foundation on which to build customer trust and loyalty. Service expectations have grown significantly in recent years and Restor is committed to being an industry leader in quality, technical expertise, and continuous improvement. Restor has and continues to make significant investments in standards and systems to meet that commitment."

You may view Restor's scope of accreditation at http://a2la.org/scopepdf/3088-01.pdf.

New Multi Measuring Interface

TDK-EPC is expanding its power factor correction portfolio with the introduction of a new EPCOS brand Multi Measuring Interface. The EPCOS MMI7000 is a universal measuring device to measure and control the most important grid parameters in a PFC system. Harmful conditions in the grid (such as high harmonic content) that negatively impact the system can be immediately detected.

The MMI7000 is designed for three-phase measuring, display and recording of values. In addition, it can be used in combination with a PF-controller series for external measurements. With dimensions of 144 x 144 mm, the MMI7000 was designed in the same way as EPCOS PF controllers and is suited for switchboard mounting. Like all controllers and measuring devices, the MMI7000 features an easy-to-use graphical menu and an integrated help function. Menu languages are English, German, Russian, Spanish and Turkish. The LCD full graphic display shows bar graphs, diagrams and different font sizes.

Areas of use include grid measuring, power measurement, harmonic measurement and energy meter. In addition, the MMI7000 can be used as an additional external measuring system accessory for the EPCOS BR6000 controller (e.g. for 3-phase measuring), and as a transmitter for external systems.

Further information on the MMI7000 Multi Measuring Interface can be found under www.epcos.com/pfc.

Enhanced Test System Provides More Flexibility

Teseq Inc., has improved its ITS 6006 (Immunity Test System) for radiated EMC immunity testing by enhancing the RF power meters used in conjunction with the unit.

The ITS 6006, ideal for use in a variety of EMC applications including information technology, medical, RF, traffic telematics and mobile communications, features two updated, rugged RF power meter models, the PMR 6006 and PMU 6006, with an expanded frequency range from 1 MHz to 6 GHz and linear measurement range of -45 dBm to +20 dBm. Both models feature a large dynamic range, fast measurement, a sturdy design and a frequency range that matches the application being performed to meet the rigorous demands of EMC immunity testing.

The PMR 6006 and PMU 6006 are used in conjunction with Teseq's compact ITS 6006, comprised of an RF signal generator with AM and PM modulators, RF switches, inputs for up to three external power meters, EUT (equipment under test) monitoring and control ports, amplifier control outputs and software for comprehensive EMC testing.

The key benefit of the ITS 6006 is that it features integrated RF switching, simplified cabling and connections and a shortened set-up time, making the system a cost-effective, integrated solution with less error sources and insertion loss. For additional information, please visit www.teseq.com or call (732) 417-0501 ext. 239.

New Testing Service Offers Product Certification for Photovoltaic Module Manufacturers

FM Approvals and TÜV Rheinland PTL LLC have joined forces to deliver a comprehensive Approval Standards available for both flexible and rigid PV modules.

The new FM Approval Standard 4476, *Approval Standard for Flexible Photovoltaic Modules*, and Approval Standard 4478, *Approval Standard for Rigid Photovoltaic Modules*, currently are undergoing final review and will be released by the end of 2010. These new standards will enable PV module manufacturers and others to obtain FM Approval for their products when used as part of an FM Approved roofing assembly.

Under an agreement signed by the two testing laboratories, FM Approvals will test the fire and natural hazard performance of PV modules as part of complete large-scale roof assemblies at its Natural Hazards Laboratory in West Glocester, R.I., USA. TÜV Rheinland PTL will provide the electrical safety and performance certification testing required by the new FM Approval standards.

FM Approvals tests and certifies products and services that meet its rigorous property loss prevention standards. Architects, consulting engineers, plant managers and product buyers rely on FM Approvals to help them make well-informed decisions about which products and services on the market will best reduce their property loss risks. For more information, visit www.us.tuv.com and www.fmapprovals.com.

CALIBRATION & REPAIR SERVICES

ESD TEST EQUIPMENT

EMC TESTERS

FIBER-OPTIC SYSTEMS

GENERATORS

COMB GENERATORS FOR EVERY NEED

- Bench Top
- Direct Connection
- Spherical Antenna
- Quasi-Peak Function

www.appliedemtech.com
410-326-6728

AET
Applied Electromagnetic Technology

PROBES

Pearson Electronics Inc

Wide Band Clamp-on Current Probe

With a Pearson Electronics Wide Band Clamp-on Current Probe, you can make accurate AC current measurements to meet many of the EMC standards. EMI, surge, lightning, and other complex current wave shapes can be viewed with a Pearson Current Probe.

A typical model has flat midband response with a 3dB bandwidth of 1 Hz to 20 MHz. Current as low as 10 micro amps (20 dBuA) and frequencies as high as 200 MHz can be measured.

We maintain a wide variety of toroid and clamp-on current probes in stock.

Pearson Electronics Inc
4009 Transport Street
Palo Alto, CA 94303 USA
Tel +1 650 494 6444
Fax +1 650 494 6716
Web www.pearsonelectronics.com

RECEIVERS, EMI/EMC

ULTRA LOW-COST COMB GENERATOR

- Powered by USB
- Directly Connects to Receivers
- Quasi-Peak Function Optional

www.appliedemtech.com
410-326-6728

AET
Applied Electromagnetic Technology

IN COMPLIANCE Magazine Marketplace

Coming in 2011: Affordable marketing options for companies seeking increased visibility throughout the year in our new Compliance Marketplace.

The Compliance Marketplace features two sections:

The first is our General Marketplace, an uncategorized space for marketers to advertise their product or service every month at very affordable rates.

The second section is a focused marketplace running in line with the focus of each monthly issue.

COMING UP
January Issue: PROFESSIONAL DEVELOPMENT
February Issue: MILITARY

Contact us today for a wide range of options and the 2011 calendar.

Sharon Smith
(978) 873-7722
sharon.smith@incompliancemag.com

Barbara Kovalchek
(978) 846-1656
barbara.kovalchek@incompliancemag.com

EVENTS

Seminars & Training

December 1 - December 2
Hazard-Based Safety Engineering (HBSE)
UL University
San Jose, CA
www.incompliancemag.com/events/101201

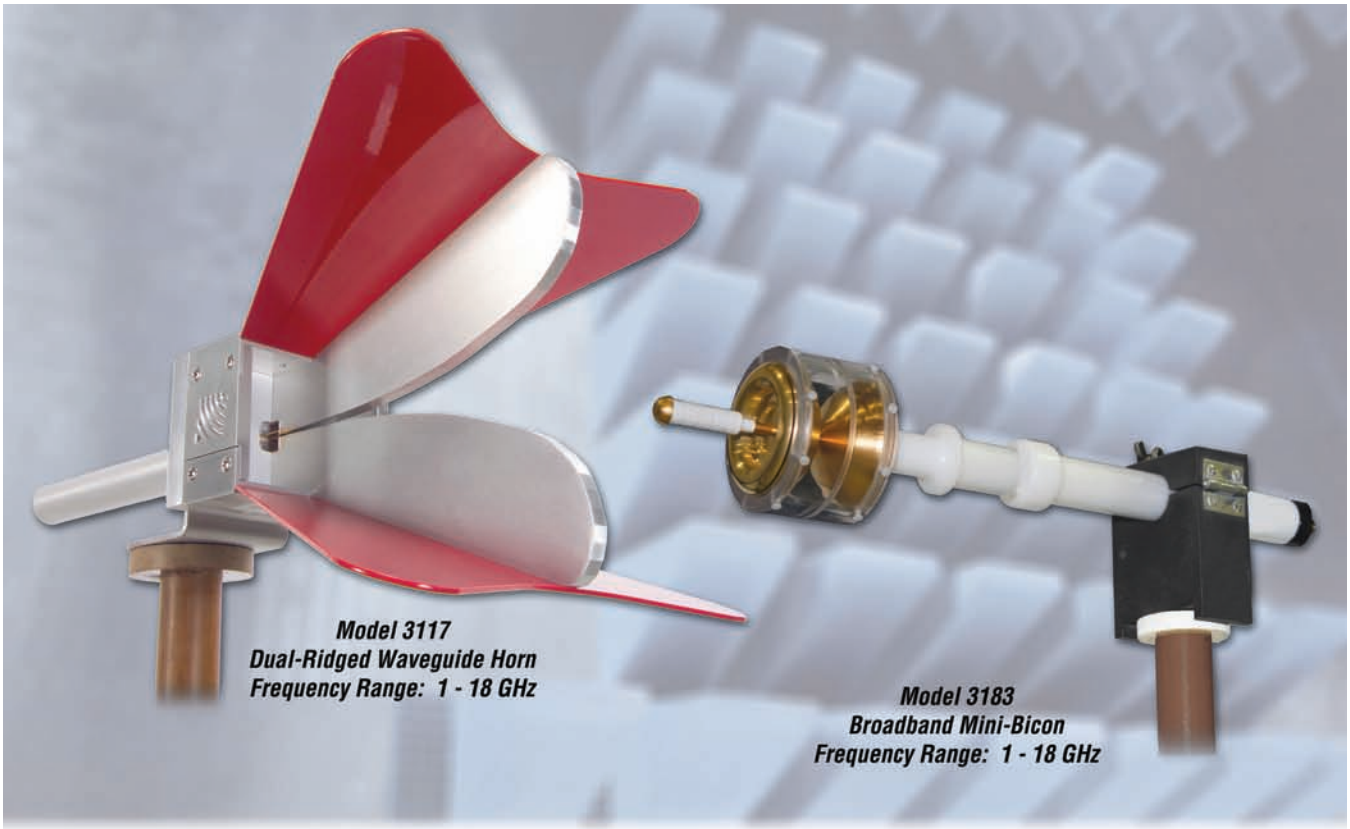
December 6 - December 10
Electronics Laboratory Technician Training
UL University
Research Triangle Park, NC
www.incompliancemag.com/events/101206_1

December 6 - December 10
2010 Wireless and EMC Seminar Program
Elliott Laboratories
Newark, CA
www.incompliancemag.com/events/101206_2

December 9
Data Acceptance Program and ISO/IEC 17025 Requirements and Implementation
UL University
Research Triangle Park, NC
www.incompliancemag.com/events/101209

Compliance Marketplace

ADVERTISERS


Model 3117
Dual-Ridged Waveguide Horn
Frequency Range: 1 - 18 GHz
Model 3183
Broadband Mini-Bicon
Frequency Range: 1 - 18 GHz

At Braden Shielding Systems, we understand that old habits are hard to break. When it comes to EMC Chambers, Braden actually manufactures our equipment in our 50,000 square foot facility. In fact, Braden Shielding Systems has manufactured and installed over 5,000 chambers worldwide.

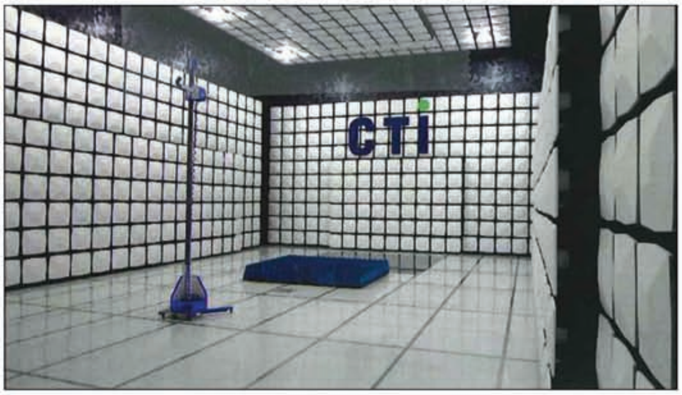
You can be assured that Braden Shielding Systems can install a chamber in your facility. We maintain an extensive list of contractors licenses and state registrations necessary to conduct business. We also keep up to date on laws and regulations in all states.

So the next time you're ready to eat a hamburger or purchase an EMC chamber, remember: ***You don't have to settle for second best just because they sell the most.***

EMC Chambers

Built to Perform!

Built to be the Best!



EMERSON & CUMING Anechoic Chambers — an Albatross Projects company

BSS BRADEN SHIELDING SYSTEMS

RAINFORD EMC SYSTEMS

9260 Broken Arrow Expressway • Tulsa, OK 74145 • Phone 918 / 624 2888 Fax 918 / 624 2886
Email: info@bradenshielding.com Website: www.bradenshielding.com