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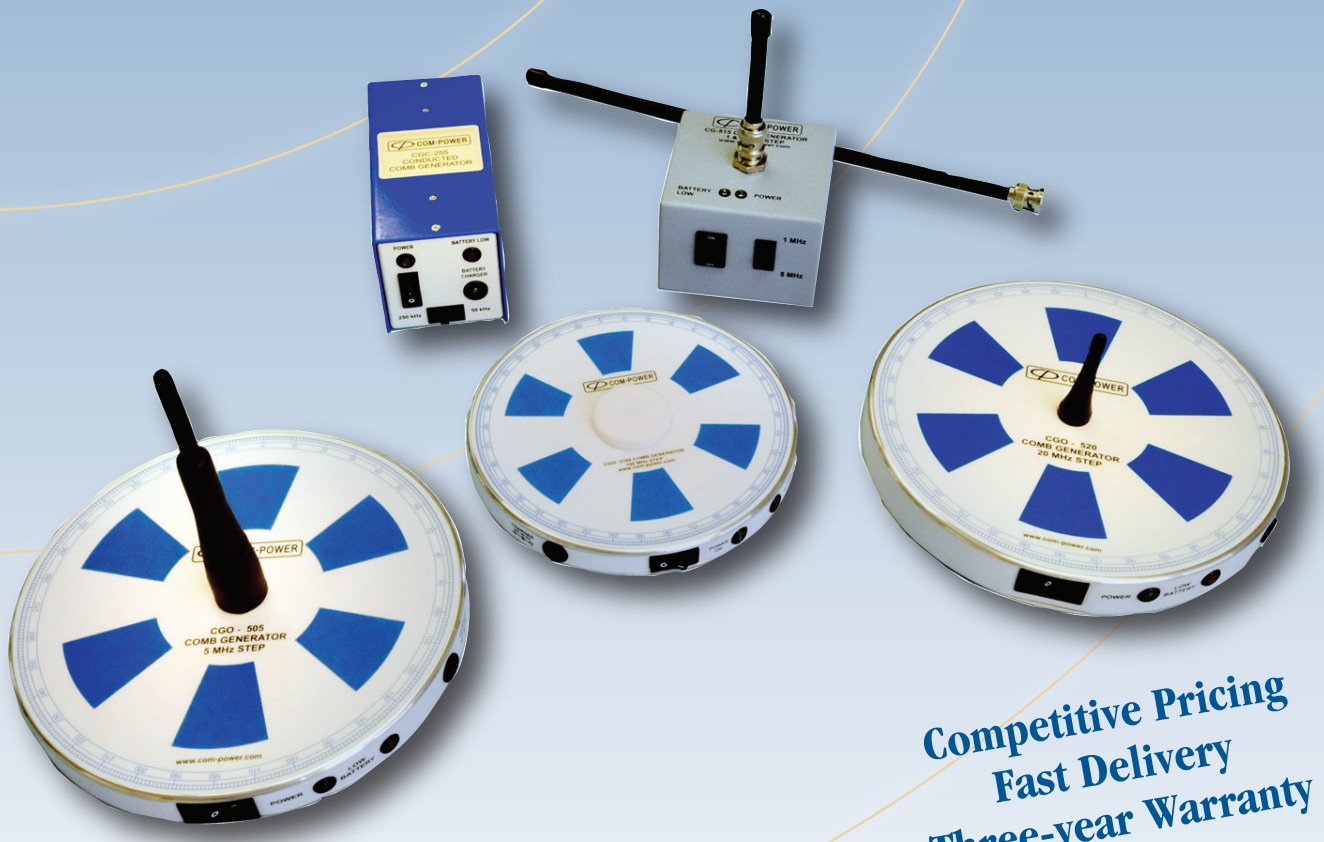
System Response to Electrostatic Discharge

A Historical Look Back
The 1977 CBEMA Paper on Electromagnetic Emanations Part 2

ESD Standards Update

EMI Reference Sources

Radiated and Conducted Comb Generators



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Letter from the editor

And the Survey Says...

Dear Readers,

As I write this letter, October has cleared the calendar and November has stepped in to take its place. Here in New England we've seen yet another severe storm, only this time it was a winter storm. In our area, the snow has mostly melted and we're getting back on with autumn.

This time of year is a time for planning, for looking back at the year and tweaking plans to improve for the upcoming year. As part of that process, we decided to send out a survey to our readers to learn more about how they use the magazine and to open a forum for feedback. I am overwhelmed with the number and quality of responses that have been pouring in from you since we sent the survey invitation! Your responses were a delightful reminder of why we decided to start *In Compliance*. We do, indeed, fill a need in the electronics compliance industry.

For those of you who responded, we thank you for your time and the very valuable feedback. Aside from your wonderful comments (which we absolutely loved) many of you requested more coverage on product safety, environmental, radio and other compliance related areas.

Throughout 2011, In Compliance attended networking events across the country. In our interactions, we identified the shifting landscape of today's compliance engineer – the scope of your jobs has broadened as companies shift and rebalance their internal structures. To continue providing the most relevant, useful information to our readership, throughout 2012 you will enjoy continued coverage of EMC related issues as well as expanded coverage in product safety and environmental compliance – coverage to match the reality of the needs of today's compliance engineer.

Winding down for 2011, we want to reassure you that we recognize your needs. Your voices are heard through multiple venues – face-to-face interaction, reader surveys, your letters and e-mails. And we are committed to continue providing the most relevant, useful compliance information in the industry.

We wish you and yours the very best throughout the holiday season and looking ahead. 2012, here we come!

Until next time,

Lorie Nichols
Editor
editor@incompliancemag.com

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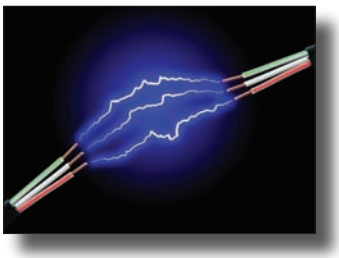

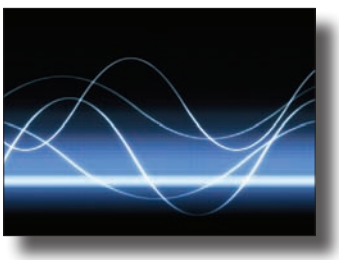

News in Compliance

FCC News

FCC Targets Illegal Jamming Devices Sold Online

The Enforcement Bureau of the U.S. Federal Communications Commission (FCC) has initiated actions against 20 separate online retailers for their illegal marketing of a variety of signal jamming devices.

The Commission's action involves the issuance of citations in connection with the marketing of more than 200 different types of devices capable of interfering with signals from cellphones, global positioning systems and wi-fi devices. In each case, the online retailer was directed to immediately cease all marketing efforts related to the illegal device, and to advise the Commission of any corrective actions taken. In addition, retailers were instructed to provide the Commission with information regarding the manufacturer and/or supplier of the illegal device.

The marketing and/or sale of any such device that interferes with authorized radio communications is a violation of section 302(b) of the Communications Act, and sections 2.803 and 15.201(b) of the Commission's rules. Further, the use of so-called jamming devices in public places could prevent a user from contacting fire or police personnel in the event of an emergency.

Continued violation regarding the marketing and/or sale of jamming devices can lead to monetary penalties of $16,000 to $112,500. The Commission also has the authority to impose separate monetary penalties for each illegal jamming device sold, or for each day on which an illegal jamming device is marketed. Additional violations can lead to seizure of equipment and imprisonment.

The Commission's Enforcement Bureau stepped up enforcement action against retailers and user of jamming devices earlier this year, and issued two separate Enforcement Advisories, once for retailers and once for consumers. The Retailer Advisory is available at www.incompliancemag.com/news/1112_01. The Consumer Advisory is available at www.incompliancemag.com/news/1112_02.

The Federal Communications Commission has proposed a plan to revamp two key telecommunications funding programs in order to direct more financial resources to the rollout of broadband Internet services.

FCC Proposes Revamp of Universal Services Fund

The U.S. Federal Communications Commission (FCC) has proposed a plan to revamp two key telecommunications funding programs in order to direct more financial resources to the rollout of broadband Internet services.

Announced in early October, 2011 by FCC Chairman Julius Genachowski, the Commission's proposal would redirect the majority of $4.5 billion in annual fees currently paid by consumers into the Universal Services Fund (USF) into a new "Connect America Fund" that would build out the infrastructure required to bring broadband Internet services to unserved and underserved areas. The Commission estimates that as many as 18 million additional U.S. consumers, mostly in rural areas, would obtain access to broadband services as a result of the program. The Commission would also introduce a competitive bidding system that would ensure the most efficient and cost-effective distribution of Connect America Fund resources, allowing the program to better control program costs.

The Commission's proposal would also revamp the current Intercarrier Compensation system (ICC), which subsidizes local telephone services for certain consumers. The Commission would immediately close loopholes and schemes that it says allow carriers to divert wireline traffic to wireless networks to avoid paying the ICC fee.

The Commission also proposes to phase down ICC charges over a multi-year period to bring intrastate access rates to parity with interstate rates, thereby providing consumers with more than $1 billion in annual benefits.

According to Genachowski, "our plan would deliver tremendous benefits for consumers. By connecting millions of unserved Americans who are being left out of the broadband revolution, this plan will bring enormous benefits to individual consumers, our national economy, and our global competitiveness."

The complete text of the press release on the Commission's proposed changes to the USF and ICC is available at www.incompliancemag.com/news/1112_03.

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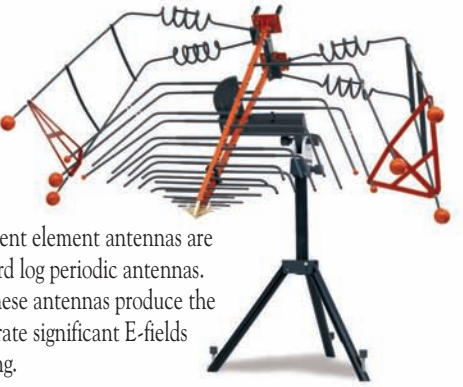

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News in Compliance

FCC News

FCC Adopts Disability Requirements for Advanced Communications Services

The U.S. Federal Communications Commission (FCC) has taken steps to broaden access to modern communications technologies for the estimated 54 million people with disabilities.

In a Report and Order issued in October, 2011, the Commission implemented key provisions of the "Twenty-First Century Communications and Video Accessibility Act of 2010" (CVAA), enacted into law in October 2010. Hailed by the Commission as "the most significant accessibility legislation since the passage of the Americans with Disabilities Act in 1990," the CVAA requires that providers of advanced communications services (ACS) and manufacturers of equipment used for ACS make their products and services accessible to people with disabilities, "unless it is not achievable to do so." The Act also requires the Commission to establish new recordkeeping and enforcement procedures for ACS manufacturers and providers.

The Commission's Report and Order provides specific details on how the Commission intends to implement the provisions of the CVAA, from defining the types of products covered under the regulations to the manufacturers and service providers subject to them. The complete text of the Commission's CVAA Report and Order is available at www.incompliancemag.com/news/1112_04.

FCC Releases Data on Internet Access

The U.S. Federal Communications Commission (FCC) has released its most recent report on access in the United States to fixed and mobile Internet connections, including information on the gap between current service levels and the benchmark Internet connection speeds recommended under the Commission's National Broadband Plan.

According to the Commission's report, entitled "Internet Access Services: Status as of December 31, 2010," 53% of fixed Internet connections to households now meet or exceed the speed tier that most closely approximates the target set in the National Broadband Plan of 3 megabits per second (Mbps) downstream and 768 kilobits per second (kbps) upstream. This penetration rate for high-speed service compares with just 49% at the end of 2009.

At the same time, high-speed Internet access for subscribers of mobile wireless service continues to outpace the growth of fixed high-speed services. At the end of 2010, 13% of mobile subscribers had access to high-speed service, more than triple the 4% penetration rate achieved by the end of 2009.

Without accounting for speed, Internet connections overall are growing. By the end of 2010, there were nearly 169 million Internet connections offering access at speeds of at least 200 kpbs, a 28% increase over 2009. Overall growth is being driven by dramatic increases in mobile connections, which increased by 63% in 2010. With more than 84 million subscribers, mobile Internet connections roughly equaled the number of fixed Internet connections at the end of the year.

The complete text of the Commission's report on Internet access is available at www.incompliancemag.com/news/1112_05.

Internet connections overall are growing. By the end of 2010, there were nearly 169 million Internet connections offering access at speeds of at least 200 kpbs, a 28% increase over 2009.

Commission Releases Data on Local Telephone Competition

The U.S Federal Communications Commission (FCC) has also released a report on local telephone competition, reflecting data submitted by incumbent and competitive local exchange carriers through December 31, 2010.

The statistics in the report include the following summary points, which highlight the growing importance of Voice over Internet Protocol (VoIP) service:

- Interconnect VoIP service subscriptions increased by 22% during 2010, from 26 million to 32 million subscriptions, while traditional switch access service

FCC News

decreased by 8%, from 127 million to 117 million lines;

- Of the 149 million total connections in service at the end of 2010, 40% were residential switched access lines, 38% were business switched access lines, 18% were residential interconnected VoIP subscriptions, and 3% were business interconnected VoIP subscriptions;
- Of the 87 million wireline residential connections, 64% were switched access lines provided by incumbent local exchange carriers (ILECs), 28.2% were non-ILEC interconnected VoIP subscriptions, 5.0% were non-ILEC switched access lines, and 0.6% were ILEC interconnected VoIP subscriptions;
- Of the 61 million wireline business connections, 63.3% were ILEC switched access lines, 29.1% were non-ILEC switched access lines, 6.9% were non-ILEC interconnected VoIP subscriptions, and 0.6% were ILEC interconnected VoIP subscriptions.

The complete text of the Commission's Report on local telephone competition is available at www.incompliancemag.com/news/1112_06.

European Union News

The EMC Directive applies to "any apparatus or fixed installation," and regulates the "ability of equipment to function satisfactorily… without introducing intolerable electromagnetic disturbances to other equipment."

EU Releases Updated Standards List for EMC Directive

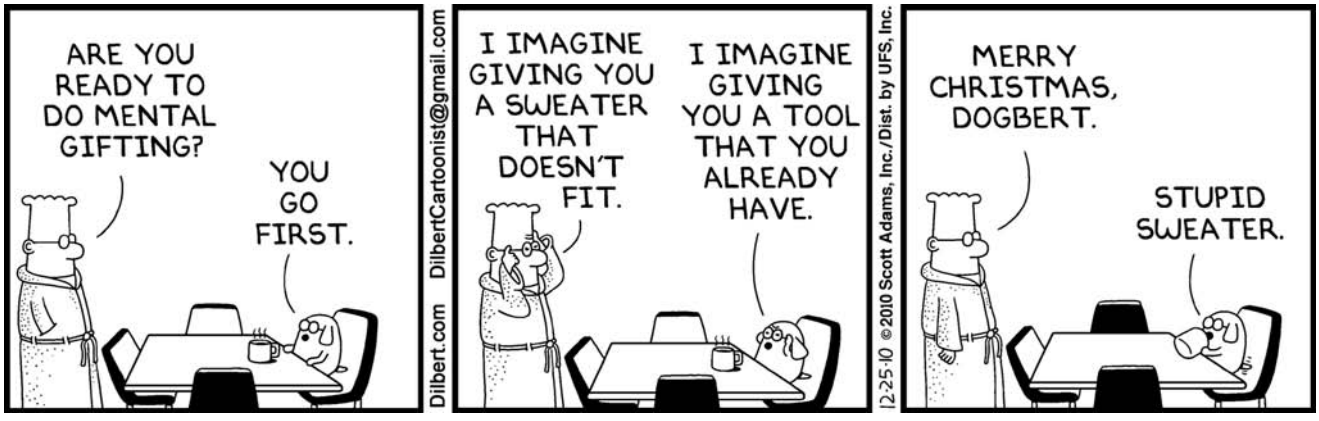
The Commission of the European Union (EU) has published an updated list of standards that can be used to demonstrate conformity with the essential requirements of the EU's directive on electromagnetic compatibility (also known as the EMC Directive, 2004/108/EC).

The EMC Directive applies to "any apparatus or fixed installation," and regulates the "ability of equipment to function satisfactorily… without introducing intolerable electromagnetic disturbances to other equipment."

The provisions of the EMC Directive do not apply to telecommunications terminal equipment, which are covered under the essential requirements of Directive 1999/5/EC (also known as the R&TTE Directive).

The updated list of CEN, CENELEC and ETSI standards that can be used to demonstrate compliance with the EMC Directive was published in September 2011 in the *Official Journal of the European Union*, and replaces all previously published standards list for the Directive.

The complete list of standards can be viewed at www.incompliancemag.com/news/1112_07.



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News in Compliance

CPSC News

CPSC Adopts Third-Party Testing Rules for Children's Products

The U.S. Consumer Product Safety Commission (CPSC) has approved new third-party testing rules for domestic manufacturers and importers of all children's products.

As a result of a 3-2 vote taken by the Commission in October 2011, domestic manufacturers and importers of all children's products will be required to test and certify that their products comply with product safety standards as required by the Consumer Product Safety Improvement Act of 2008.

In two separate but related actions, the Commission also voted 5-0 to issue a Notice of Proposed Rulemaking on the selection of representative samples that can be tested for compliance with the new requirements, and to seek public comment on opportunities to reduce the cost of third-party testing.

In a statement following the vote to implement the new testing requirements for children's products, CPSC Chairman Inez Tenenbaum and Commissioners Robert Adler and Thomas Moore noted that the Commission had received within the space of just one week over 10,000 letters from consumers in all 50 states supporting the implementation of the third-party testing rules.

Companies are already required to conduct initial testing on some products, such as children's cribs, pacifiers and metal jewelry. The new testing requirements go beyond initial testing to ensure that products continue to meet applicable safety standards.

Firms will also be required to keep records on the testing and certification of their products, and to periodically retest products to ensure continued compliance with the safety requirements.

The testing and certification requirements will go into effect 15 months after their publication in the *Federal Register*, on or about January 2013.

Companies are already required to conduct initial testing on some products, such as children's cribs, pacifiers and metal jewelry. Testing is also required for children's products that include small parts, or which are painted. The new testing requirements go beyond initial testing to ensure that products continue to meet applicable safety standards.

Alarm Company Recalls Carbon Monoxide Detectors

ADT Security Services Inc. of Boca Raton, FL has announced the recall of about 20,000 of its model CO 1224T carbon monoxide (CO) detectors manufactured in China and Mexico.

ADT reports that, due to improper wiring, the CO detectors fail to signal when they reach the end of their useful life, posing a CO poisoning hazard to consumers. The company has not received any reports of incidents or injuries related to the detectors, but has initiated the recall to prevent any such incidents in the future.

The recalled CO detectors were installed by ADT between October 2008 and December 2010 as part of its home security systems.

Additional information about this recall is available at www.incompliancemag.com/news/1112_08.

NiMH Battery Charger Recalled

Horizon Hobby Inc. of Champaign, IL is recalling about 975 of its Losi NiMH Start-Up Combo Charger manufactured in China.

According to the company, the charger and battery can emit excessive heat, posing a burn and fire hazard to

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CPSC News

consumers. Horizon Hobby says that it has received eight separate reports of the batteries emitting excessive heat, but no reports of consumer injuries related to the recalled product.

The NiMH battery chargers were given away for free or for a nominal charge by hobby stores nationwide from January through March 2011.

More information about this recall is available at www.incompliancemag.com/news/1112_09.

Lithium-Poly Battery Pack for Electric Bicycles Recalled

Electric Motion Systems LLC of Dulles, VA has issued a recall for about 70 of its rechargeable lithium-poly batteries manufactured in China and used in electric bicycles and propulsion systems.

The company reports that the recalled battery packs can overheat and catch fire. To date, it has received three reports of the battery packs catching fire, and one incident which resulted in a consumer receiving a minor burn.

The recalled battery packs were sold at bicycle shops nationwide and through the company's website from October 2009 through November 2010 for between $900 and $1000. The battery packs were also sold as part of propulsion system kit for between $2325 and $2675.

Additional details about this recall are available at www.incompliancemag.com/news/1112_10.

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News in Compliance

UL Standards Updates

Underwriters Laboratories has announced the availability of these standards and revisions. For additional information, please visit their website at www.ul.com.

STANDARDS AND OUTLINES

UL 651: Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
New Edition dated October 25, 2011

UL 651A: Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit
New Edition dated October 26, 2011

UL 884: Standard for Underfloor Raceways and Fittings
New Edition dated October 20, 2011

UL 987: Standard for Stationary and Fixed Electric Tools
New Edition dated October 19, 2011

UL 1004-4: Standard for Electric Generators
New Edition dated October 25, 2011

UL 1067: Standard for Electrically Conductive Equipment and Materials for Use in Flammable Anesthetizing Locations
New Edition dated September 30, 2011

UL 1995: Heating and Cooling Equipment
New Edition dated October 14, 2011

UL 2572: Standard for Mass Notification Systems
New Edition dated October 7, 2011

UL 2580: Standard for Batteries for Use in Electric Vehicles
New Edition dated October 13, 2011

UL 2760: Surface Coatings: Recycled Water-borne
New Edition dated October 6, 2011

UL 2761: Sealants and Caulking Compounds
New Edition dated October 3, 2011

UL 2762: Adhesives
New Edition dated October 3, 2011

UL 2763: Energy Efficient Harmonic Cancellation Transformers
New Edition dated October 5, 2011

UL 2764: Gas-Fired Condensing Hot Water Heating Boilers
New Edition dated September 30, 2011

UL 2765: Indirect Fired Domestic Hot Water Tanks
New Edition dated October 5, 2011

UL 2766: Energy Efficient Heating/ Cooling Systems for Buildings
New Edition dated October 17, 2011

UL 2767: Paint and Varnish Remover
New Edition dated September 30, 2011

UL 2769: Corrosion Control Products
New Edition dated October 6, 2011

UL 2770: Commercial Car Wash
New Edition dated October 7, 2011

UL 2771: Paper Products
New Edition dated October 6, 2011

UL 2774: Events
New Edition dated October 12, 2011

UL 2779: Dust Suppressants
New Edition dated October 12, 2011

UL 2780: Urinal Blocks
New Edition dated October 12, 2011

UL 2781: Pool and Spa Water Treatment Products
New Edition dated October 12, 2011

UL 2782: Solid Biofuels
New Edition dated October 7, 2011

UL 2783: Instant Hand Antiseptic Products
New Edition dated October 7, 2011

UL 2784: Sustainability for Hand Cleaners
New Edition dated October 3, 2011

UL 60335-1: Safety of Household and Similar Appliances, Part 1: General Requirements
New Edition dated October 31, 2011

REVISIONS

UL 130: Standard for Electric Heating Pads
Revision dated October 14, 2011

UL 262: Standard for Gate Valves for Fire-Protection Service
Revision dated October 11, 2011

UL 262: Standard for Gate Valves for Fire-Protection Service
Revision dated October 21, 2011

UL 283: Standard for Air Fresheners and Deodorizers
Revision dated October 5, 2011

UL 325: Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems
Revision dated October 13, 2011

UL 452: Standard for Antenna - Discharge Units
Revision dated October 6, 2011

UL 484: Standard for Room Air Conditioners
Revision dated October 21, 2011

UL 563: Standard for Ice Makers
Revision dated September 30, 2011

UL Standards Updates

UL 567: Standard for Emergency Breakaway Fittings, Swivel Connectors and Pipe-Connection Fittings for Petroleum Products and LP-Gas
Revision dated October 21, 2011

UL 674: Electric Motors and Generators for Use in Hazardous (Classified) Locations
Revision dated August 12, 2011

UL 746A: Standard for Polymeric Materials - Short Term Property Evaluations
Revision dated October 25, 2011

UL 793: Standard for Automatically Operated Roof Vents for Smoke and Heat
Revision dated September 30, 2011

UL 1059: Standard for Terminal Blocks
Revision dated October 14, 2011

UL 1472: Solid-State Dimming Controls
Revision dated October 14, 2011

UL 1559: Standard for Insect-Control Equipment - Electrocution Type
Revision dated October 10, 2011

UL 1569: Standard for Metal-Clad Cables
Revision dated October 7, 2011

UL 1574: Standard for Track Lighting Systems
Revision dated October 27, 2011

UL 1673: Standard for Electric Space Heating Cables
Revision dated October 14, 2011

UL 1693: Standard for Electric Radiant Heating Panels and Heating Panel Sets
Revision dated October 14, 2011

UL 1778: Uninterruptible Power Systems
Revision dated October 14, 2011

UL 1990: Standard for Nonmetallic Underground Conduit with Conductors
Revision dated October 6, 2011

UL 2523: Standard for Solid Fuel-Fired Hydronic Heating Appliances, Water Heaters, And Boilers
Revision dated October 17, 2011

UL 60691: Standard for Thermal-Links - Requirements and Application Guide
Revision dated October 20, 2011

UL 60745-2-15: Hand-Held Motor-Operated Electric Tools - Safety - Part 2-15: Particular Requirements for Hedge Trimmers
Revision dated September 30, 2011

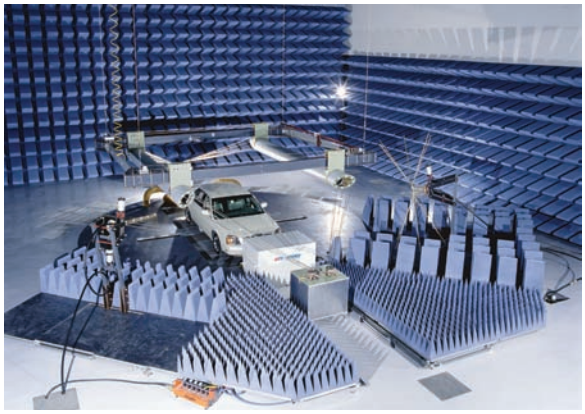
UL 60745-2-1: Hand-Held Motor-Operated Electric Tools - Safety - Part 2-1: Particular Requirements for Drills and Impact Drills
Revision dated October 26, 2011

UL 60947-7-3: Low-Voltage Switchgear and Controlgear - Part 7-3: Ancillary Equipment - Safety Requirements for Fuse Terminal Blocks
Revision dated October 14, 2011

UL 60947-7-2: Low-Voltage Switchgear and Controlgear - Part 7-2: Ancillary Equipment - Protective Conductor Terminal Blocks for Copper Conductors
Revision dated October 14, 2011

UL 60947-7-1: Low-voltage switchgear and Controlgear - Part 7-1: Ancillary Equipment - Terminal Blocks for Copper Conductors
Revision dated October 14, 2011

Automotive Test Chambers



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Staying In Touch

The iNARTE office has switched to a wintertime schedule. With the shorter daylight hours and the local school schedules, we will be open at the usual 9:00 am to 5:00 pm Monday to Thursday, but only from 9:00 am to 3:00 pm on Fridays.

Of course you can call outside these hours and leave us messages. We will get back to you with detailed answers as soon as we can. Answers to most questions, together with the forms for exam registration and certification applications and renewals, are all available on our web site www.narte.org.

IEEE PSES SYMPOSIUM 2011

As reported last month, we were fortunate to be able to attend the IEEE PSES event in San Diego. The venue was the Hilton Mission Valley Hotel, whose staff did a great job of accommodating the attendees and catering the event. If you have not visited San Diego for many years, as we had not, you will be amazed at how the city has grown. The best new experience for us was the short walk from the hotel to the San Diego Trolley, with direct service to Old Town and then convenient connections to all parts of the city and surrounding areas.

Figure 1: The PSES needed to alert the city to the "unsafe sail condition" on the Star of India.

The PSE Society is still a relatively small but very enthusiastic group. This year about 150 of the approximate 875 society members attended the symposium, but iNARTE was not able to persuade anyone to register for the certification examination. We could not understand why anyone would turn down an eight hour examination, when the only real alternative would be to wander around San Diego (Figure 1).

ANNUAL MEETING WITH KEC IN JAPAN

iNARTE travelled directly to Kyoto, Japan from the PSES event in San Diego. Kyoto is the headquarters for KEC, our Japanese Regional Partner. Once again KEC was the winner of our Best Regional Partner award for 2011 (Figure 2), having registered more than 250 candidates for certification examinations this year.

KEC offers iNARTE certification programs in Product Safety Engineering and EMC, together with the new jointly developed EMC Design Engineer program. Almost half of iNARTE's PSE certificate holders are in Japan and the other half are in the USA. We have been unsuccessful in developing interest in this certification discipline outside these two countries. Having the ability to discuss the future strategic direction for this program with KEC immediately following the PSE symposium was most opportune.

A careful analysis of the industry sector affiliations of our certificate holders shows that the vast majority are involved with the Audio/Video and IT communities. The only other two sectors well represented are Consumer Electrics/ Electronics and Medical/Measurement/ Calibration/Laboratory Equipment. With this demographic in mind, we have

decided to modify the format of our PSE examinations for 2012.

With just a couple of months to go before we close the Master EMC Design Engineer certification under our grandfatherd scheme, participation and interest has been high, both here and in Japan. KEC held their first conventional examination for the basic EMC Design Engineers on October 24th. We had thought that about 20 candidates would register for this first time event, but twice that number signed up. We look forward to tabulating the results of that first examination with great interest.

A NEW PSE EXAM FORMAT FOR 2012

Our practice in the past has been to offer the PSE Exam in two Parts, similar to many of our other programs. Part 1, a four

Figure 2: Brian Lawrence presents the Regional Partner award for 2011 to KEC's new Senior Managing Director, Mr. Yuichi Fujii, here with members of KEC's iNARTE support team.

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hour session, was mainly populated with general knowledge questions common to most industries. Part 2, another four hour session, had a lot of industry specific standards and practices questions for different industries.

In coordination with KEC, as discussed above, we feel that applicants with specific knowledge from one industry sector may not want to take an examination where a high percentage of questions relate to specifications and standards peculiar to another sector. Accordingly we plan to change the exam format for 2012 to allow applicants to certify their knowledge and expertise in specific sectors, while still demonstrating a high level of general knowledge in the discipline.

The new Part 1 exam will be divided into two sections, Part 1(a) will be a 4 hour session and Part 1(b) will be a two hour session. Questions in both sections will be general in nature. The only reason for having two sections is to allow candidates a reasonable break period. Part 1(a) will be 48 questions, from which 40 should be answered. Part 1(b) will be 24 questions, from which 20 should be answered.

The new Part 2 will be a 2 hour session with 24 questions, from which 20 should be attempted. Candidates can select from three Part 2 paper choices according to their industry sector experience: A/V and IT, Consumer Electrics/Electronics, and Medical/Measurement/Calibration/ Laboratory Equipment. Candidates will receive both Part 1(b) and Part 2 papers together, and will be able to allocate the four hour session between the two papers according to their own desire.

A passing grade will be an average of 70% correct answers between the Part 1(a), Part 1(b) and Part 2 papers, but must include a minimum of 14 correct answers from Part 2. Successful candidates will receive their certificates with an endorsement showing their specific field of expertise. Candidates may attempt different Part 2 papers at any time and add further endorsements to their certificate.

REGISTER FOR CERTIFICATION EXAMS

There are no more symposiums or workshop events planned for 2011 where iNARTE will proctor certification examination. However, all examination candidates should visit our web site at http://www.narte.org/h/testcenters.asp to find an Authorized Test Center that is convenient for travel. Then in the registration page at http://www.narte.org/h/examregform.asp, just enter that selected test center and we will make the arrangements from that point.

If none of our centers are conveniently located for you, please email or call our office. We probably can arrange one of the following alternatives:

a. Find a local Community College that is willing to proctor an exam.

b. Ask a responsible person from another department in your own company who is willing to proctor the exam.

c. A local public library may provide a quite room and a proctor. IN

(the author)

BRIAN LAWRENCE began his career in electromagnetics at Plessey Research Labs, designing "Stealth" materials for the British armed services. In 1973 he moved to the USA and established a new manufacturing plant for Plessey to provide these materials to the US Navy. In 1980 he joined the "Rayproof" organization to develop an RF Anechoic Test Chamber product line. As a result of acquisitions, Rayproof merged into Lindgren RF Enclosures, and later into ETS-Lindgren. Following a career spanning more than 40 years in the electromagnetic compatibility field, Brian retired as Managing Director of ETS-Lindgren UK in 2006. Later that year he assumed the position of Executive Director for the National Association of Radio and Telecommunications Engineers, NARTE. Now renamed iNARTE, the Association has expanded its operations and is today an affiliate of RABQSA under the overall banner of the American Society for Quality, ASQ.

QUESTION OF THE MONTH

Last month we asked:

What is the minimum acceptable insulation thickness for primary windings of a limited power supply transformer of an IT product operated at 120VAC?

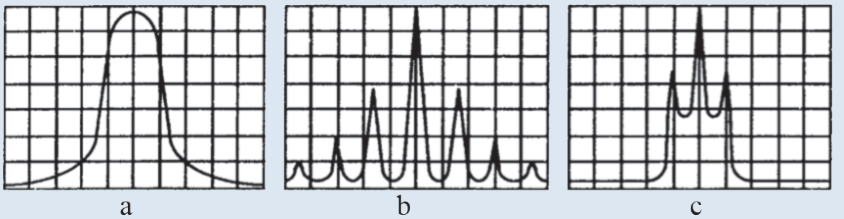
A. 1.0 mm
B. 0.4 mm
C. 0.1 mm
D. 0.8 mm

The correct answer is B. 0.4 mm

The question this month is:

Which of the spectrum analyzer CRT displays of the same signal (below) shows the narrowest resolution bandwidth?

A. a
B. b
C. c



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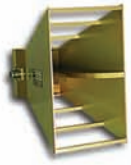

12 tripods standing
11 probes injecting
10 monopoles receiving
9 horns - a - gaining
8 dipoles testing
7 low loss cables
6 log periodics
FIVE golden loops
4 preamplifiers
3 current probes
2 portable kits
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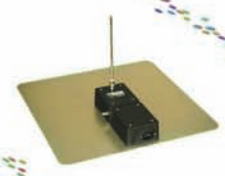

Happy Holidays

and a low noise New Year.

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MR. Static

Static Electricity and People

BY NIELS JONASSEN, sponsored by the ESD Association

The question of interactions between the phenomenon of static electricity and people can be looked at in two ways: how people cause static chargings and how they are affected by it. The first of these may not always be well understood, but is generally not controversial. The second, however, is the subject of much unsubstantiated speculation.

INTRODUCTION

Associate Professor Neils Jonassen authored a bi-monthly static column that appeared in *Compliance Engineering Magazine*. The series explored charging, ionization, explosions, and other ESD related topics. The ESD Association, working with *IN Compliance Magazine* is re-publishing this series as the articles offer timeless insight into the field of electrostatics.

Professor Jonassen was a member of the ESD Association from 1983-2006. He received the ESD Association *Outstanding Contribution Award* in 1989 and authored technical papers, books and technical reports. He is remembered for his contributions to the understanding of Electrostatic control, and in his memory we reprise "Mr. Static".

~ The ESD Association

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Mr. Static Column
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How People Cause Static

The best-known charging process created by people is that of walking across an insulated floor covering. At first glance, this process seems simple. The contact and friction between the shoe soles and the floor cause a charge separation for each step. This charge makes the voltage of the human body capacitance increase until the unavoidable leakage current balances the charging current.

But the charge is separated at the interface between the shoe sole and the floor covering, and the sole is insulating. So how does the charge get transferred from the underside of the sole to the person?

Maybe it doesn't—maybe the person does not in fact achieve a net charge. All we see, in that case, is the effect of the induction caused by the charge on the sole. Mind you, this effect might well raise the person's voltage to substantial levels, with the net charge remaining zero. Or there may be leakage around the edges of the sole, or even a combination of these processes.

Oddly enough, nobody has ever really looked into this problem. And when you pose it to people presenting papers on the topic, they tend to become fidgety.

Another common way people can charge themselves is by removing an item of clothing. When a sweater is rubbing against a blouse, charges may be separated, but the voltage of the person will not increase, since equally large opposite charges are in principle located on the person. But when the sweater is removed, with, for example, a negative charge, the positive charge from the blouse provides a positive voltage.

Incidentally, the little zap you might feel at your ear when removing the sweater is not a sign of charging. Quite the contrary: it's a discharge (and it's not a spark, but a brush discharge). Sliding out of a car seat produces a similar charging process, and the slight shock you may feel is caused by you discharging to the car (and in this case with a *spark*), not by the car being charged. The latter process came to an end in the 1930s with the introduction of conductive rubber in tires.

How Static Electricity Affects People

Electrical Shocks

The best known effect of static on people, and the only proven effect in the opinion of many scientists, is that of the shock from a spark discharge. This usually occurs when a charged person touches a grounded object, or comes into contact with another person who is at a different potential. Although this phenomenon is well known, there are no well-defined ranges for what level of body voltage will result in discharges that can be felt.

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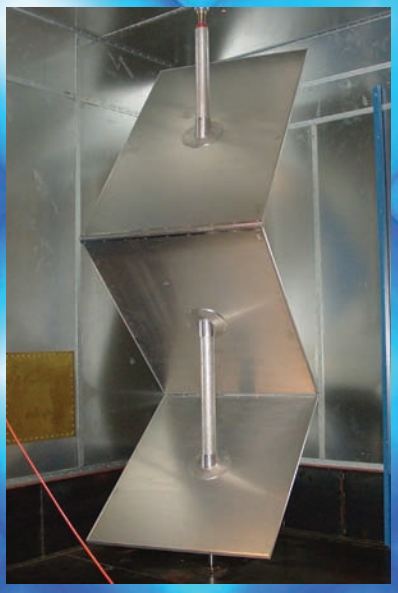

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MR. Static

Few people, however, will notice discharges at voltages lower than about 1000 V. Most people will start to feel an unpleasant effect around 2000 V. Almost everyone will complain when exposed to discharges at voltages above 3000 V.

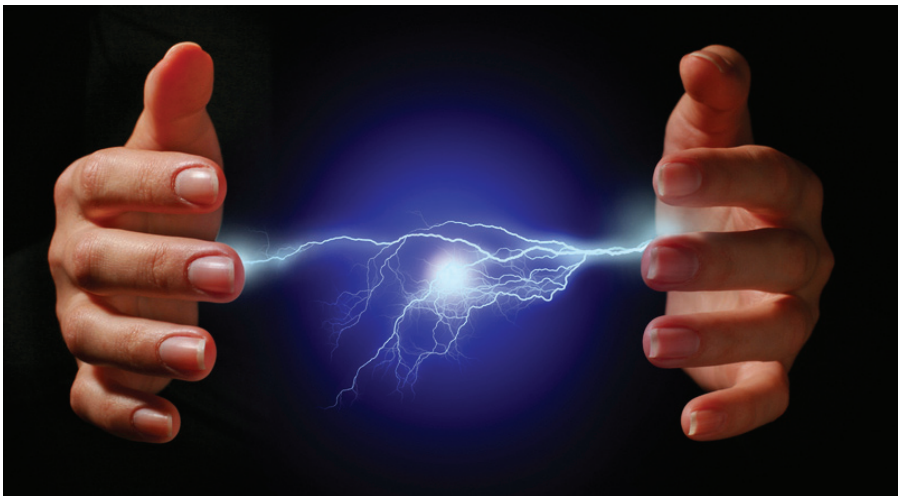
How high can body voltage be from walking on an insulating floor with insulating shoes? Certainly voltages in the range of 10–20 kV have been encountered under certain conditions, but in my opinion, the sometimes-quoted maximum value of about 35 kV is apocryphal. Long before that kind of voltage is reached, corona discharges would probably occur from the nose, ears, and other protrusions.

It is interesting to note that the question of whether the discharge of a conductor to a human body might have beneficial effects was once a serious question. In the 18th century, electrotherapy was widely used. In one application, capacitors, known as Leyden jars, were charged to voltages in the tens of kilovolts and discharged to paralyzed limbs. The resulting jerk was interpreted as a sign of a positive effect.

In most cases, however, the effects of static electricity on human beings have been considered harmful, or at least unwanted. In the age of the sick-building syndrome, it was almost unavoidable that some of the many unspecific effects of an imperfect indoor climate should be attributed to the exotic phenomenon of static electricity. Static charging has sometimes been the suspected cause of headaches, dry mucosa, itchy skin, and other similar ailments. Rarely in such cases has any possible mechanism or explanation been suggested that was based on well-documented studies.

Plating Out

There is, however, one physical effect of static electricity that has some likelihood of causing physiological or hygienic problems: the effect an electric field around a person has on airborne particulates.



If a person is positively charged, he or she will attract negatively charged particles from the air. Or, as a physicist might prefer to phrase it, the field around the body will enhance the plateout of negatively charged particles onto the clothes and exposed skin. But neutral particles will also be attracted, because they will be polarized, and because the fields, in general, will always be inhomogeneous. The field around a person may, as explained above, originate from charges being separated by walking on an insulated floor covering. But it may also be caused by proximity to a television or computer monitor.

Interestingly, if no one is close to a television or computer screen, the field will move toward the screen. Consequently, this is where particles will plate out, with resultant smudging. When a person is close to the screen, however, the field will also converge on that person's face, especially around protrusions such as the nose and ears.

Several scientific projects have demonstrated that electric fields around a person dramatically increase the plateout rate of airborne particulates. It has been suggested that if such particulates are of an allergenic nature, the plateout might result in an increased occurrence of skin irritation or disease. Such a relation, however, has not been demonstrated.

Are Ions Good for You?

A somewhat similar process is the effect on atmospheric ions of an electric field around a person (for a definition and description of the physical properties of atmospheric ions, see my column in the May/June 1999 issue of *Compliance Engineering*, page 24).

It has often been claimed that an excess or deficit of one of the polarities of ions in the air inhaled has a direct effect on human beings. Decades ago, one such claim was that an excess of negative ions would increase the vibration frequency of the cilia in the respiratory tract, thereby improving the cleaning efficiency of the cilia in the upper respiratory region. This theory was apparently supported by experimental results in the 1940s and 1950s and was widely quoted. About 1970, however, it was put to rest—or at least it should have been—because new investigations with more up-to-date instrumentation demonstrated conclusively that there

It is interesting to note that the question of whether the discharge of a conductor to a human body might have beneficial effects was once a serious question. In the 18th century, electrotherapy was widely used. In one application, capacitors, known as Leyden jars, were charged to voltages in the tens of kilovolts and discharged to paralyzed limbs. The resulting jerk was interpreted as a sign of a positive effect.

was no such effect. Nevertheless, you may still find the ion-cilia relation cited in medical and quasi-medical publications.

An even more popular claim is that an excess of negative ions makes the air feel fresh and clean, while an excess of positive ions makes the air feel stuffy. Since this kind of vague effect is extremely difficult to prove or disprove, let it suffice to observe that the stuffy air under a thunder cloud has an excess of negative ions, while the fresh air on a mountain top is rich in positive ions. Thus there seems to be more to air quality than ion balance.

But let us nevertheless assume that the relative concentration of positive and negative ions in the air we breathe has an influence on our health. It is then clear that a person who is surrounded by an electric field (because he or she is charged) will inhale fewer ions than an uncharged person. If this person is positively charged, he or she will repel positive ions. Although the body will attract negative ions, the ions will be deflected to the skin and thus be removed from the inhaled air. And even if the person is not charged, most of the ions in the air inhaled will probably plate out in the airways before they even reach the bronchi.

The whole question about the fate of ions in the air we breathe still needs a lot of experimental work. It has been argued that since a negative ion is likely to contain an oxygen molecule, inhaling negative ions must be a good thing. Beyond what I've noted about the plate-out on the skin and in the upper part of the airways, it should be pointed out that even in the highest possible ion concentrations there are trillions of uncharged oxygen molecules for each negative ion.

Over the last five to six years there have been many reports (at least in Europe) on the reputed benefits of exposing the skin of a person suffering from rheumatic or other ailments to a highly ionized airflow with ions of only one polarity.

In order for the person thus treated not to be charged, he or she must be connected to ground. The stream of ions will then cause a current from the point of impact to the ground connection. According to some of the reports, the effect of the treatment is highly dependent on where on the body the ground connection is placed. Of course, you can also create a current through the body simply by applying two or more electrodes, but doing so limits the path of the current to some degree.

If the ionized air does have an effect, it may be because the current originates from a larger area and thus has a greater chance of finding the path with the largest effect. This also depends on the placing of the counter electrode or ground connection.

Please notice that I said if the ionized air has an effect.

The results that I keep hearing about are not from regular scientific investigations with double-blind tests and all that jazz. But they do keep coming, and I don't want to completely rule out the possibility that they are real.

I started working with ions in about 1958 to investigate some sensational claims from a national ion-guru in Denmark on the effects and behavior of ions in indoor air. I almost got crucified for requesting scientific documentation for the claims (such as that the air in a room with a vinyl floor had a bad ion balance). My above commentary on the possible effect of ionized air on the skin does not mean that I have mellowed over the years and relented in my requirements for documentation. Rather the contrary. I still love to play the role of St. Thomas the Doubter. IN

(the author)

NIELS JONASSEN, MSC, DSC, worked for 40 years at the Technical University of Denmark, where he conducted classes in electromagnetism, static and atmospheric electricity, airborne radioactivity, and indoor climate. After retiring, he divided his time among the laboratory, his home, and Thailand, writing on static electricity topics and pursuing cooking classes. Mr. Jonassen passed away in 2006.

ON Your Mark

On Your Mark

BY GEOFFREY PECKHAM

Globally standardized symbols are available for you in two categories, those that identify functions and controls, and those that identify safety concerns.

Symbols are standardized worldwide by two highly-active global committees. ISO/TC 145 is the horizontal committee of the International Organization for Standardization (ISO) that addresses standardization of non-electrical function and control symbols and all safety symbols. The International Electrotechnical Commission's IEC SC3C committee defines function and control symbols for electrical equipment.

Here's how these global symbol standards are related and differ:

- Non-electrical function and control symbols are standardized in ISO 7000. Electrical function and control symbols are standardized in IEC 60417. Both standards are titled, *Graphical symbols for use on equipment*. Safety symbols are standardized in ISO 7010.
- ISO/IEC function and control symbols tend to be more abstract whereas the ISO safety symbols are typically more representational in form.
- ISO safety symbols use a colored surround shape (circle, square or triangle) to define their overall safety function and to make these symbols more easily noticed and recognized.
- ISO/IEC function and control symbols are designed according to a strictly defined grid template that standardizes the size, shape and line thickness of the symbol's elements. This helps in obtaining both uniformity and maximum visual "legibility" for these symbols, many of which are used in small sizes on control buttons and small labels.

To illustrate the points made above, Figure 1 shows the three IEC function/control symbols used to identify ground connections. All three symbols are related by their similar vertical/horizontal design element and they are similarly abstract. But the use of the curved design element in 5018 and 5019 easily differentiates one symbol from another. Here are the precise definitions for each symbol:

No. 5017 Earth (ground): Identifies an earth (ground) terminal in cases where neither the symbol 5018 nor 5019 is explicitly stated.

No. 5018 Noiseless (clean) earth (ground): Identifies a noiseless (clean) earth (ground) terminal, e.g. a specially designed earthing (grounding) system to avoid causing malfunction of the equipment.

No. 5019 Protective earth (ground): Identifies any terminal which is intended for connection to an external conductor for protection against electrical shock in case of a fault, or the terminal of a protective earth (ground) electrode.

(In the next article in this series, I will explain what the standards say as to when and where to use the grounding symbols and the role training plays in their comprehension).

In contrast to ISO/IEC function and control symbols, ISO safety symbols use color and shape to define an overall safety meaning. As shown in Figure 2, the ISO safety sign types are:

Warning sign: Black banded yellow triangle with black symbol

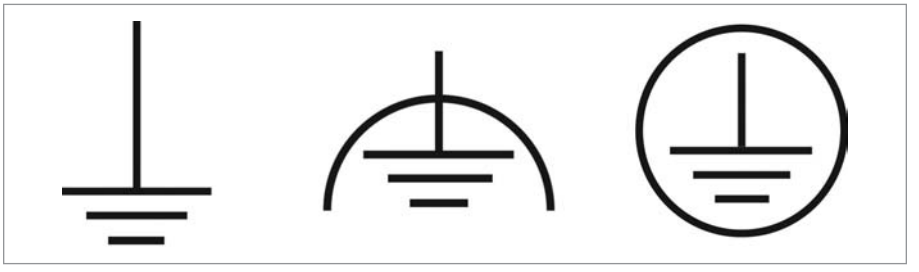


Figure 1: IEC 60417 ground symbols (from left to right: 5017, 5018 and 5019)

Prohibition sign: Black symbol behind red circle with slash

Mandatory action sign: Blue circle with white symbol

Safe condition/location of safety equipment sign: Green rectangle with white symbol

Fire safety/location of fire equipment sign: Red rectangle with white symbol

Once standardized, ISO/IEC function and control symbols and ISO safety symbols do not change and that's good for product manufacturers, especially those with a global market. These world-wide symbol standards let you conform at the outset without having to reinvent the process of properly identifying functions, controls and safety concerns each time you design a product. Further, from the product user's viewpoint there is greater certainty of meaning when seeing familiar, standardized symbols. That's the beauty and practical usefulness of international symbol standards, assuring a clear win for both the manufacturer and the user.

For more information about safety signs and symbols, visit www.clarionsafety.com. IN

Figure 2: ISO safety symbol examples (from left to right: laser beam, no open flame, wear face shield, assembly point, fire hose)

(the author)

GEOFFREY PECKHAM is president of Clarion Safety Systems and chair of both the ANSI Z535.2 Standard for Environmental and Facility Safety Signs and the U.S. Technical Advisory Group to ISO Technical Committee 145- Graphical Symbols. Over the past two decades he has played a pivotal role in the harmonization of U.S. and international safety standards dealing with safety signs, colors, formats and symbols.

FUTURE of EMC Engineering

The Future as Compliance Engineers

BY MARK MONTROSE

For most with an affinity to compliance engineering, little time is spent on thinking about our future. Too often we get caught up in details of our daily work without considering exciting opportunities on the horizon. There are several items one must recognize in order to be successful in the future.

1. Open our minds to a new way of thinking. There is usually more than one way to solve a problem. Creativity is a wonderful thing. Using the "not-invented-here" syndrome or being adamant about your way is the only way may cause more problems than you can imagine. Remember, there will always be someone who knows more than you and is willing to give advice.

2. Embrace advances in technology with high levels of enthusiasm. Doing the same thing over and over can become boring. Look to advances in technology as opportunities to have fun, even if it means spending long hours to understand something that you have never had exposure to.

3. Minimize use of electricity and the need to build more power plants. The world has a voracious appetite for electricity and there is a finite number of power generating plants with an aging transmission line infrastructure. By designing energy efficient products, we will be able to conserve our electrical power for a world dependent on electronic products and services.

4. Specializing within electrical engineering hinders our ability of being a solid designer. We must understand other areas of engineering such as material science, physics and thermodynamics. Senior engineers must also learn about other facets of the engineering discipline such as computational analysis. Advances in technology means that things that we use to take for granted now play a critical role in system design and cannot be ignored.

5. Being able to work with fellow engineers with different specialties,

such as speaking their language or understanding their unique talents and ways of doing design and development is becoming critical. Many companies have offices all over the world. Cultural differences and language may cause problems when things need to get done quickly.

6. Joining professional Societies with intent of advanced or continued education and networking. This is a key element to being a successful engineer, especially with technology yet to be invented. Professional societies host conferences and produce technical publications. Social networking is a great way to not only ask but receive help should a difficult problem arise and there is no easy answer. There is always someone with higher levels of knowledge with answers to questions and enjoys publishing or presenting their knowledge.

What EMC engineers face now will surely be the same in the future, except that the level of complexity will increase significantly. What is critical for success in the future is continuing education and networking, remembering the six points above. IN

(the author)

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.

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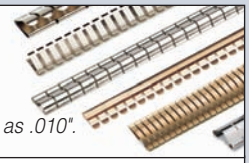

BeCu Contact Rings can be fabricated from Finger Stock in a range of profiles.

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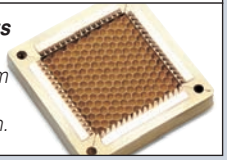

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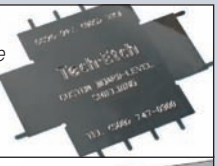

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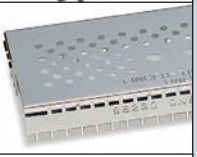

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Software as a Medical Device

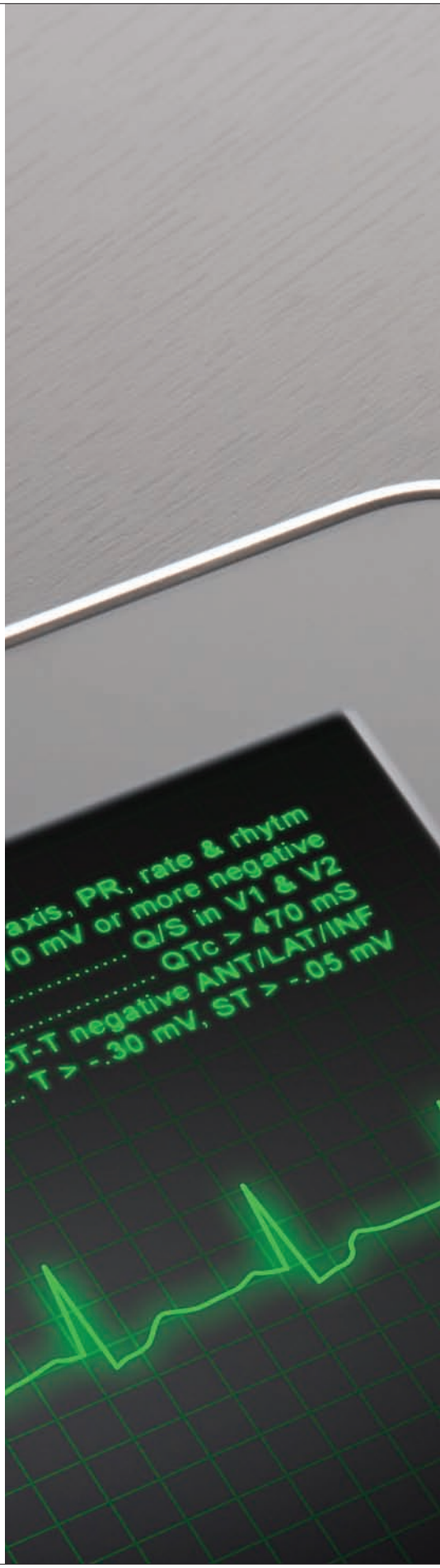
Should you be CE marking your software?

BY BRIAN McAULIFFE

The last decade has seen unprecedented advances in both medical device and information technologies. As the technologies used in these two sectors continue to develop and converge, new markets are created and manufacturers have responded by releasing new products and solutions. One such marketplace is Healthcare IT (HIT), where, for example, solutions are now being implemented enabling physicians to view patient records on a tablet device or remotely from the care location on a smart phone.

With the emergence of this HIT marketplace, and the regulations that come with it, manufacturers of Information Technology Equipment (ITE) and medical device solutions will be required to apply a new approach to compliance. Hardware compliance testing will still be required, but, in addition, items such as risk management, software validation, solution reliability and interoperability will become embedded in the de-facto language of conformity assessment.

This two-part series of articles provides an overview of the compliance related developments in the HIT domain – covering regulatory developments both recent and future, standards development activity and analysis of the potential impact to the in-house compliance process.



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A Healthcare IT solution is essentially a deployed combination of clinical medical equipment together with the supporting IT infrastructure – workstations, backbone network and storage, software applications and services..

This first article begins with an overview of HIT to set it in a context relevant for compliance engineering analysis, and then proceeds to discuss the regulatory situation in the European Union (EU). Subsequent articles will cover the regulatory framework in other markets and an analysis of the related international standards development activity.

A TYPICAL HIT SOLUTION

An HIT solution is essentially a deployed combination of clinical medical equipment together with the supporting IT infrastructure - workstations, backbone network and storage, software applications and services. The overall solution may be provided by one vendor or by some combination of IT equipment suppliers, IT services and clinical equipment suppliers.

The topology of HIT solutions will vary depending on the application. As can be seen from Figure 1 it can be simply confined to a specific clinical application environment such as a laboratory analyzing samples where results are stored locally.

Alternatively, as in Figure 2 (page 30), the solution may incorporate various healthcare information sub-systems, (e.g. laboratory, radiology, order entry), patient administration systems, working across multiple hospital sites and interconnecting remotely with primary care physician and community care centres.

From a compliance perspective, both examples contain some mixture of the following key elements:

- IT hardware such as servers and storage equipment;

Figure 1

Since its publication in 1993 the Medical Devices Directive has effectively only been applied to the hardware aspects of medical electrical equipment.

- medical (clinical) devices;
- standalone application and management software
- embedded software

The efficiencies and improvements to healthcare services that HIT solutions offer have been welcomed by all concerned. However as their prevalence increased the question of how they could potentially impact on patient safety due to their integral part in clinical diagnosis and treatment has begun to receive attention.

In the EU, it was recognized by the authorities that the existing legislation covering medical devices did not clearly identify how software used in a medical application should be treated. Manufacturers and Competent Authorities alike did not have a consistent framework for the assessment of medical software.

SOFTWARE - A MEDICAL DEVICE?

In the EU both ITE and medical electrical equipment fall under the scope of the New Legislative Framework (NLF).with typical ITE equipment being covered by a combination of the Low Voltage/ EMC/R&TTE Directives and electrical medical equipment by the Medical Devices Directive (MDD). Both categories also carry the CE mark as an indication to market surveillance authorities that their conformity has been assessed.

Since its publication in 1993 the MDD has effectively only been applied to the hardware aspects of medical electrical equipment, with the embedded software required by the product to perform its function being assessed by default as needed to support the hardware testing. Standalone medical software used in conjunction with other clinical or IT equipment had not been considered at all up to then.

This, according to the EU Commission, was never the intention of the MDD and so, in 2007, the MDD was amended[1] to specifically highlight the requirement for standalone software to be considered as a medical device. Article 1.2(a) was modified to explicitly include the word 'software' as one of the articles to be considered a medical device, subject to the other qualification criteria listed as part of the definition. The definition is copied here below for information:

> *2. For the purposes of this Directive, the following definitions shall apply: (a) 'medical device' means any instrument, apparatus, appliance,* ***software****, material or other article, whether used alone or in combination, including the software intended by its manufacturer to be used specifically for diagnostic and/or therapeutic purposes and necessary for its proper application, intended by the manufacturer to*

be used for human beings for the purpose of:

- *diagnosis, prevention, monitoring, treatment or alleviation of disease,*
- *diagnosis, monitoring, treatment, alleviation of or compensation for an injury or handicap,*
- *investigation, replacement or modification of the anatomy or of a physiological process,*
- *control of conception,*

and which does not achieve its principal intended action in or on the human body by pharmacological, immunological or metabolic means, but which may be assisted in its function by such means;

Software qualification and classification

Since the amendment came into effect on March 21, 2010 there has been a comprehensive debate amongst the interested parties (Member State Competent Authorities, Commission services, industry and notified bodies) with a view to arriving at agreement on which types of standalone software

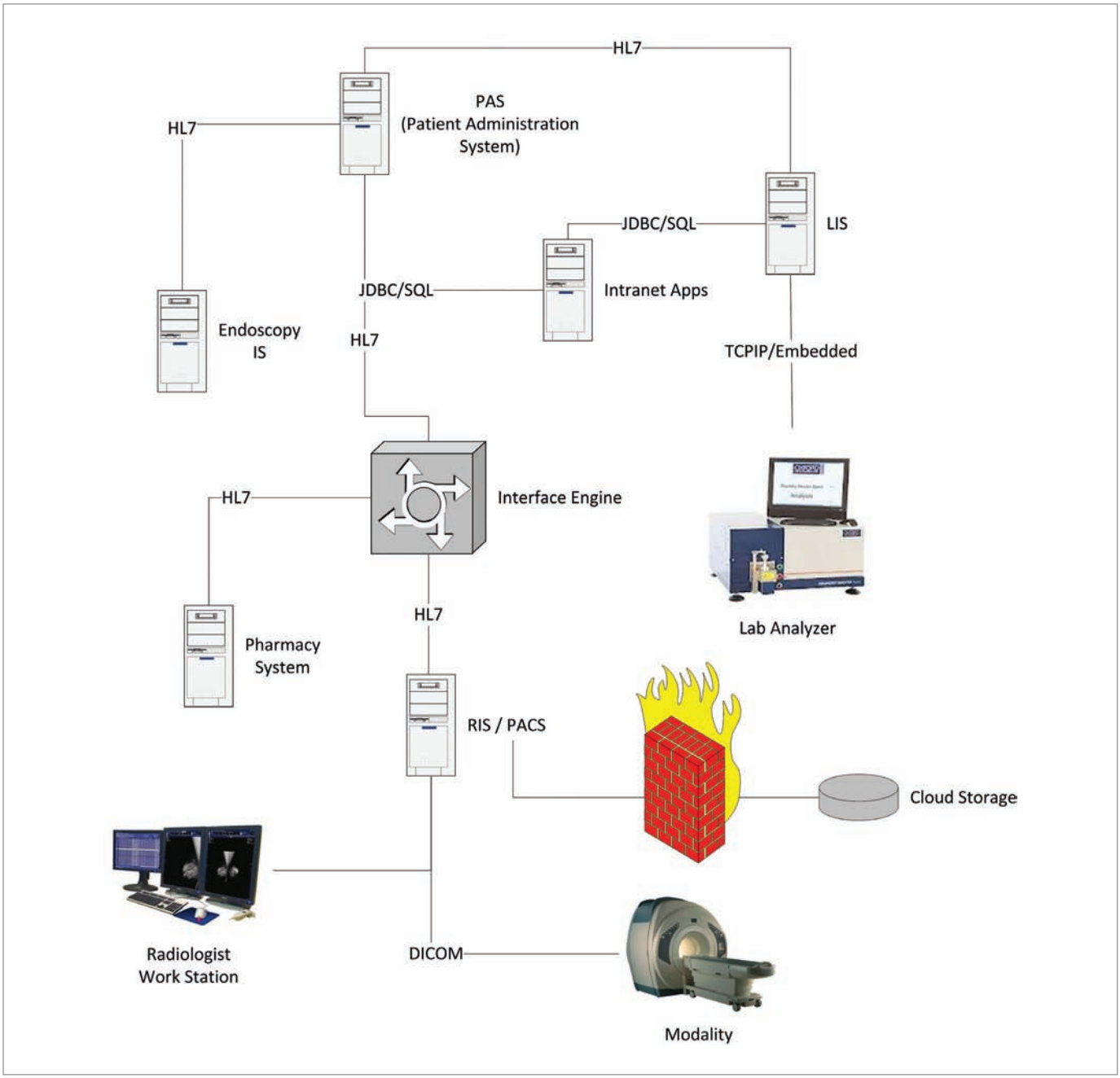


Figure 2

application should qualify as medical devices, according to the definition above and for those that do, how they are to be classified.

Qualification of software as a medical device

Unit B2 of the Health and Consumers Directorate of the EU Commission have been working to produce a guideline document to assist with the process of qualifying software as a medical device. The guideline document is nearing completion and is currently with the Medical Devices Expert Group (MDEG) for review and approval. It is anticipated that the guideline will be published as a MEDDEV early in 2012. MEDDEVs are guidelines aimed at promoting a common approach by manufacturers and Notified Bodies involved in conformity assessment procedures according to the relevant annexes of the MDD, and by the Competent Authorities charged with safeguarding Public Health.

In deciding whether or not a standalone software is a medical device it is anticipated that some of the key considerations enshrined in the guidance will be :

- The decision to consider standalone software as a medical device shall be based on its *intended purpose*, as defined by the manufacturer. A device must have a medical purpose to be qualified as a medical device.
- Is the software performing an action on data different from storage, archival, lossless compression, communication or simple search?
- Standalone software that is not a medical device, but is an accessory to a medical device, *may* fall under the scope of the MDD.
- The risk related to malfunction of standalone software used within a healthcare environment is in itself not a criterion for whether or not it qualifies as a medical device.

Classification of standalone medical software

Once a standalone software is **qualified** as a medical device as per the qualification criteria defined, the guidance document will then proceed to clarify how the standalone software is to be **classified** as per Annex IX of the MDD

These classifications are of critical importance as each classification specifies a different route to conformity assessment, some involving Notified Bodies and others not (the MDD uses classifications I, II, IIIa and IIIb).

Other considerations

The other significant change in the MDD amendment is the introduction of an essential requirement relating to *risk management of software*.

MDD Annex I requirement 12.1 is amended as follows:

(g) the following Section shall be inserted:

'12.1a For devices which incorporate software or which are medical software in themselves, the software must be validated according to the state of the art taking into account the principles of development lifecycle, risk management, validation and verification.';

This essential requirement will have to be underpinned by appropriate EU Official Journal harmonized standards for software development. The recently published IEC 80001-1 standard on risk management for IT networks incorporating medical devices is one such candidate standard.

It is widely recognized that eHealth has major business potential for industry, with associated benefits to the citizen and the healthcare profession, but to make eHealth services available and beneficial, safe and secure interoperability is a pre-requisite.

FURTHER REGULATORY DEVELOPMENTS FOR HIT

So far this article has focused on standalone software and how the MDD has been amended to clarify the framework for how such software is to be assessed. While this is a significant move, it is only one element of wider developments underway in the EU in the field of eHealth, HIT being a subset of the eHealth ecosystem.

The key components of these developments are discussed in the following sections.

Standardization Mandate M/403

This mandate was issued by the Commission to the European Standards Development Organizations (SDO) on March 6, 2007. The title of the mandate is *Mandate to the European Standardisation Organisations CEN, CENELEC and ETSI in the field of Information and Communication Technologies, applies to the domain of eHealth*.

It is widely recognized that eHealth has major business potential for industry, with associated benefits to the citizen and the healthcare profession, but to make eHealth services available and beneficial for EU health professionals and citizens, safe and secure interoperability is a pre-requisite. The primary driver for the Mandate is therefore to achieve common agreed upon set of *standards and conformance verification procedures* that will facilitate safe and secure interoperability. In this context, interoperability is more than just technical interoperability, but also includes semantic and linguistic criteria, cultural aspects, and organizational issues.

Phase 1 is now complete. This involved listing all existing relevant standards and technical reports, and defining a plan for Phase 2 that will enable the objectives of the mandate to be realized, with a prioritization given to the most crucial standards.

Phase 2 is scheduled to complete in 2012. The top priority use cases being worked on are Patient Summary (electronic health record) and ePrescription. One of the five pillars of this Phase 2 work is development of *conformance test plans and tools*. The outcome from this work will be a set of protocol suites that HIT solutions must conform to.

Standardization Mandate M/403

Mandate to the European Standardisation Organisations CEN, CENELEC and ETSI in the field of Information and Communication Technologies, applies to the domain of eHealth was issued by the Commission to the European Standards Development Organisations (SDO) on March 6, 2007.

Commission Recommendation 2008/594/EC

This recommendation, issued in July 2008, relates to cross-border interoperability of electronic health record systems. It provides a set of guidelines for developing and deploying interoperable electronic health record systems, contributing to the main Commission policy objective of achieving overall European eHealth interoperability by the end of 2015.

So this can be achieved the Recommendation invites Member States to undertake actions at a number of levels:

- political
- organizational
- technical interoperability of EHR systems
- semantic interoperability of EHR systems
- certification of EHR systems
- protection of personal data
- monitoring and evaluation
- education and awareness training

It further expands the certification of EHR systems action as follows in Article 9(b):

"put into place a joint or mutually recognised mechanism for ***conformity testing and certification of interoperable electronic health records and other eHealth applications****, such as the techniques and methodologies offered by various industry consortia";*

There is a clear indication in this article that not only is the intention to introduce a conformity assessment scheme for eHealth, but that the

It has always been and remains today a challenge for regulatory authorities and standardization bodies to keep abreast with the rate of development in technology driven markets.

Commission will leverage the existing work performed by the ICT fora and consortia standardization organizations e.g. ANSI HL7 and SNOMED[2]. This move to recognise industry fora and consortia is further evidenced by the review that is currently in progress of the ICT standardization process in Europe.

ACTIONS

The Commission will work with Member States Competent Authorities and all interested stakeholders to:

- **Key Action 13:** Undertake pilot actions to equip **Europeans with secure online access** to their medical health data by 2015 and to achieve by 2020 widespread deployment of telemedicine services;
- **Key Action 14:** Propose a recommendation defining a **minimum common set of patient data** for interoperability of patient records to be accessed or exchanged electronically across Member States by 2012[1];
- **Other actions:**

Foster EU-wide **standards**[2], **interoperability testing and certification** of eHealth systems by 2015 through stakeholder dialogue; Reinforce the **Ambient Assisted Living (AAL) Joint Programme** to allow older people and persons with disabilities to live independently and be active in society.

[1] In line with data protection requirements

[2] Under Mandate 403 (CEN)

Table 1

Europe 2020 Strategy and Digital Agenda

Adopted in May 2010 the Digital Agenda is a flagship initiative for smart, sustainable and inclusive growth to develop an economy based on knowledge and innovation.

It contains a renewed commitment to eHealth through aiming to ensure:

- patient empowerment – support patients access to eHealth services, including patients records and telemedicine services
- sharing knowledge for better care – minimum data set for patients' summaries
- *interoperability - standardization, certification and testing*

Copied in Table 1 are two of the key actions from section 2.7.2 of the *Digital Agenda* document.

Again, the importance of standards, interoperability testing and certification are highlighted as fundamental to the success of eHealth. In pursuit of this objective the Commission is supporting, via the epSOS initiative, a large scale pilot project across Member States, for the purpose of demonstrating interoperability of patient record systems and e-prescriptions.

CONCLUSIONS

It has always been and remains today a challenge for regulatory authorities and standardization bodies to keep abreast with the rate of development in technology driven markets. eHealth is one such market but with even the smallest probability of a potential impact to patient safety due to an unregulated marketplace we can expect to see significant effort applied to this area over the coming months and years. There are interesting times ahead for us traditional compliance engineering professionals. IN

NOTES

1. Directive 2007/47/EC of the European Parliament and of the Council of 5 September 2007
2. HL7: www.hl7.org; SNOMED: http://www.ihtsdo.org

(the author)

BRIAN McAULIFFE

is currently employed as a Senior Engineer with Dell Inc. based in Ireland and working in the Global Regulations & Standards group. Brian has worked in compliance for 20 years with compliance testing laboratories and a number of product development companies in the telecoms and ITE sectors. He is active in the standards development process being an expert member of CENELEC and IEC technical committees and has been Chairperson of TechAmerica Europe Standards & Certification working group since 2009. Brian is currently studying part time for an M.Sc. in Health Informatics from the University of Limerick (www.ul.ie). These materials are not offered as and do not constitute legal advice or opinions. Seek independent legal advice with respect to compliance or any particular issue. The content of this document reflects the opinions of the individual author and may not reflect the opinions of Dell Inc.

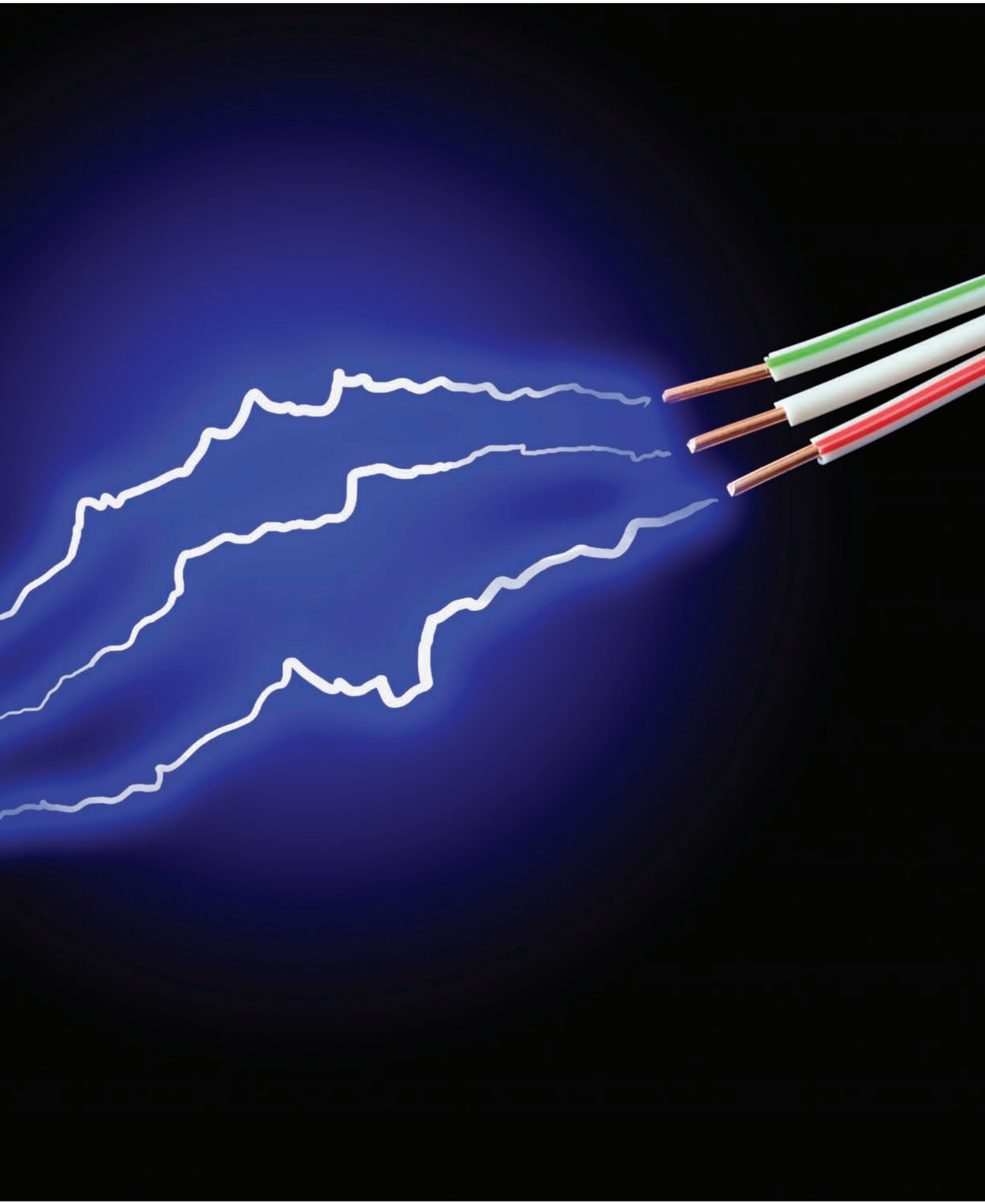
GR-1089 Fault Testing Changes for Issue 6

Changing your cross voltage tester to meet the new requirements

BY JEFF LIND AND JOSÉ CABANILLAS

GR-1089-CORE has always required the Cross Voltage Test in its Section 4. This test simulates communication wires contacting power wires. Previously, the Cross Voltage Test has been conducted at 600V, but the new Issue 6 has decreased this voltage to 425V. The 425V test uses the same current levels as were required for the 600V test, so this is a decrease in the amount of power that is required to be produced by testers designed to perform the Issue 6 Cross Voltage Test. In this article, we will address the two new tables describing the tests, discuss changes and note the tests that have not changed, and offer some general guidelines for parties who would like to modify existing Cross Voltage Testers to perform the Issue 6 Test Suite at 425V.

Some authorities have decided to adopt Issue 6, but with the Cross Voltage Testing voltage remaining at the old value of 600V. Footnote 6 of Table 4-4, while not addressing the situation specifically, offers guidance in this instance by stating that the same power noted in the table for the 425V tests must be used if the tests are conducted at 600V. It is worth noting that even if the Cross Voltage Test is conducted at 600V under Issue 6, the 600V, 60A test is not conducted as it has been dropped from Issue 6. Therefore, even if your authority requires 600V testing, there is an advantage to using Issue 6.



Issue 6 simplifies the presentation of the Cross Voltage Test. Previous editions of GR-1089-CORE spread the tests over several tables and the new format is much clearer.

In another change, Issue 6 simplifies the presentation of the Cross Voltage Test, with all First-Level Tests shown in Table 4-4 and all Second-Level Tests shown in Table 4-5. Previous editions of GR-1089-CORE spread the tests over several tables. This new format is much more clear.

Editorial changes have simplified the presentation of all the tests, and the deletion of the 60A 600V test has made life easier for test equipment designers. Still, Tables 4-4 and 4-5 and their footnotes are complex and have many required tests. Following the general direction of the tests in Issue 6 compared to Issue 5, Tables 4-4 and 4-5 are equivalent to or lesser than the old standard in power and voltage. Because of this rare occurrence, it is possible to revise an existing Cross Voltage Tester to have it test to the new requirements.

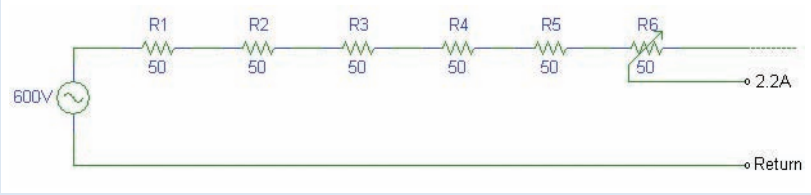
Some existing Power Cross Voltage Testers have only a subset of the tests noted in Tables 4-4 and 4-5 and, depending on the tests, may not need any changes or only a simple change to the input voltage (meaning that no hardware changes are required). Testers which have all the tests included will probably need some reworking. Also, please note that there will not be a drop in the power requirement of the tester itself because the most stringent test from the point of view of the testing equipment, the 277V, 25A, 15 minute test, is still included as Surge Test No. 1.1 of the Second-Level Power Fault Tests (Table 4-5).

When looking over the requirements, the first thing that is noticeable is the absence of the 1000V 5A, 600V 2.2A and the 600V 3A test, in addition to the 600V 60A test. For new AC Cross Voltage Testers made to Issue 6, this change will allow the 425V and/or 600V and 1000V tap to be built with less current capability, saving cost.

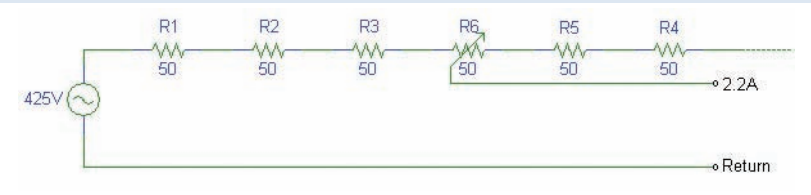
A discussion of these tests must also begin with a discussion of Table 4-5, Note 5, which applies to all 425V tests. Note 5 states, "These tests can be performed at greater than 425Vrms (i.e. 600 Vrms), with the approval of the manufacturer of the equipment, but the current is to be as specified." Along with this information is the knowledge that Verizon has accepted GR-1089 Issue 6, but has made an exception to the 425V levels; testing for Verizon must be done using 600V.

CHANGES REQUIRED FOR UPGRADING TESTERS TO ISSUE 6

The following information is presented for evaluation of existing Issue 5 and prior testers to determine what changes and upgrades are needed to successfully test to Issue 6. In the cases of the 425V rms tests, no changes may be required if 600V as allowed



GR-1089 Issue 5 600V test at 2.2A, R6 adjusted at 22.73 ohms



GR-1089 Issue 6 425V test at 2.2A, R6 swapped with R4 and adjusted at 43.18 ohms

Figure 1: Demonstration of resistance change

Surge Test Number	Min. Peak Open-Circuit Voltage	
1	50V	
1.1	Adjusted	
1.2	50V	
2	100V	
2.1	Adjusted	
2.2	100v	
3	200V	
4	1000V	

Table 1: Table 4-4 First-Level Power Fault Tests

If capability for both voltage levels is desired, a tap arrangement can be implemented to allow either voltage to be selected as required.

under Note 5 is the only test voltage. If capability for both voltage levels is desired, a tap arrangement can be implemented to allow either voltage to be selected as required. Depending on the construction of the existing Cross Voltage Tester, one of two methods can be used to reduce the output voltage level to 425V while preserving the specified current levels. The first method is used when rheostats are employed, usually in low power tests. The second method is used when fixed resistors are used in higher output tests.

Method 1: Modification of Rheostat Taps

Rheostats are used in low power taps, and the adjustment is used to trim the output for some tests which require the current output to be set at the circuit protection value. In these circuits, no tester rework will be needed, but any calibrations done on the rheostats will have to be performed again by conducting a short circuit test with a current meter connected. The variac or voltage supply should be set for 425V, and the rheostat should be adjusted to produce the desired current flow. In the spreadsheet below, we have noted the probable rheostat taps as "Low Power".

Method 2: Modification of Fixed Resistor Taps

Fixed resistor taps are used for the higher power output requirements. When reducing the voltage and keeping the current constant, the changes are relatively simple as no further resistances need to be added. A typical tap will use a number of fixed resistances and, at the end of the tap, a variable resistor used to compensate for resistor tolerance. To make the changes, it is necessary to swap the variable resistor to the new end position of the new bank (Figure 1).

GR-1089, TABLE 4-4, FIRST-LEVEL POWER FAULT TESTS

Unchanged Taps

Table 1 shows the First-Level Power Fault Tests. There are some tests which are carried over verbatim from Issue 5; there are no changes to older AC Power Fault Testers for the tests shown.

Taps Requiring Changes

Issue 6 does have some changes for the First-Level Tests. These changes are due to the relaxation of test voltage from 600 to 425V. Depending on the requirements of your testing authority, these changes may not be needed if testing is to continue at 600V. If testing at 425V is anticipated, the changes should be evaluated, as some of the adjusted taps may require reworking (Table 2 on page 38).

	Min. Peak Short-Circuit current per conductor	Duration	Issue 5 Resistance	Resistance Needed on Issue 6	Difference	Comments
	0.33A	15 min	150Ω	150Ω	0Ω	No change
	.033A @ 100V	15 min	150Ω	150Ω	0Ω	No change
	Adjusted	15 min	150Ω	150Ω	0Ω	No change
	0.17A	15 min	150Ω	150Ω	0Ω	No change
	0.17A @ 100V	15 min	150Ω	150Ω	0Ω	No change
	Adjusted	15 min	150Ω	150Ω	0Ω	No change
	0.47	1 sec	425Ω	425Ω	0Ω	No change
	1A	1 sec	1000Ω	1000Ω	0Ω	No change

Surge Test Number	Min. Peak Open-Circuit Voltage	Min. Peak Short-Circuit current per conductor	Duration	Issue 5 Resistance	Resistance Needed on Issue 6	Difference	
3.1	425V	1A	1s	600 Ω	425 Ω	175 Ω	
3.2	Adjusted	1A @ 425V	1s	600 Ω	425 Ω	175 Ω	
3.3	425V @ 1A	Adjusted	1s	600 Ω minimum	425 Ω minimum	175 Ω minimum	
5	425Vrms	N/A	5s	N/A	N/A	N/A	
6	425V	0.50A	4s	1200 Ω	850 Ω	350 Ω	
7	425V	0.71A	2s	845.1 Ω	598.6 Ω	246.5 Ω	

Table 2: Table 4-4 First-Level Power Fault Tests

GR-1089, TABLE 4-5, SECOND-LEVEL POWER FAULT TESTS

Unchanged Taps

Table 3 notes the unchanged Second-Level Power Fault Tests. These tests are carried over verbatim from Issue 5; there are no changes to older AC Power Fault Testers for the following tests shown in Table 3.

Taps Requiring Changes

Issue 6 has some changes for the First-Level Tests. These changes are due to the relaxation of test voltage from 600 to 425V. Depending on the requirements of your testing authority, these changes may not be needed if testing is to continue at 600V. If testing at 425V is anticipated, the changes should be evaluated, as some of the adjusted taps may require reworking (Table 4 on page 40).

CONCLUSION

Issue 6 of GR-1089-CORE reduces the voltage level for the Cross Voltage Test as shown in the newly edited Tables 4-4 and 4-5. The previous level of 600V has been reduced to 425V and the 600V, 60A test has been dropped. In the tables shown above, we have given general guidelines for the hardware changes needed to refit a tester made for GR-1089-CORE Issue 5 to test to the new Issue 6 requirements.

Despite the relaxation of the Cross Voltage Test in Issue 6, Verizon has advised that starting in 2012, testing will be done to Issue 6 but using the previous 600V test levels. Until it is clear that the 425V levels will be used, testers should delay making any changes to existing Issue 5 test equipment, while new purchasers should explore procuring a tester that can provide 425 and 600V levels. Any changes to Issue 5 testers should be made in a fashion that still allows use of the 600V taps. IN

Surge Test Number	Min. Peak Open-Circuit Voltage	Min. Peak Short-Circuit current per conductor	Duration	Issue 5 Resistance	Resistance Needed on Issue 6	Difference	Comments
1	120V	25A	15 min	4.8Ω	4.8Ω	0Ω	No change
1.1	277V	25A	15 min	11Ω	11Ω	0Ω	No change

Table 3: Table 4-5 Second-Level Power Fault Tests

	Comments
	This is considered a low power test. Normally fixed resistors are not used for this tap, rheostat is used instead. If your tester is using rheostat, confirm that 425 Ω is within its range. If it is using fix resistors, the 600 Ω resistor should be reduced by 175 Ω. The total power of the resistors should be rated for 600W* for 1 second.
	Should use same resistors as Surge 3.1, variac voltage should be adjusted.
	Variac voltage is fixed at 425V, rheostat is needed to adjust the current. Resistance value should be 425 Ω or higher.
	The components of the capacitors and transformer remains the same, it is just a lower voltage test.
	This is considered a low power test. Normally fixed resistors are not used for this tap, rheostat is used instead. If your tester is using rheostat, confirm that 850 Ω is within its range. If it is using fix resistors the 1200 Ω resistor should be reduced by 350 Ω. The total power of the resistors should be rated for 212.5W* for 4 seconds.
	This is considered a low power test. Normally fixed resistors are not used for this tap, rheostat is used instead. If your tester is using rheostat, confirm that 598.6 Ω is within it's range. If it's using fix resistors the 845.1 Ω resistor should be reduced by 246.5 Ω. The total power of the resistors should be rated for 301.8W* for 2 seconds.

***Note:** The dissipation power on most common resistors is ten times higher when used for 5 seconds or less. Refer to the resistor datasheet maximum overload specification. It is recommended to have a proper temperature control inside the test equipment.

(the author)

JEFFREY D. LIND

is president of Compliance West, USA and has contributed his 33 years of extensive electrical engineering expertise to help further the advancement and expansion of the Compliance West, USA brand. Jeff's comprehensive understanding of the industry, ranging from sales and marketing to product development, has helped establish Compliance West as a driving force within the medical and industrial testing industries.

Jeff launched his career in the electrical product safety industry working at Underwriters Laboratories (UL) from 1976-1982 doing project engineering and follow up services management. He then lent his skills to Atari™ as a product safety engineer for a year. Shortly after moving to San Diego in 1983 to work with Sega Gremlin™, Jeff decided to branch out on his own and launched Compliance West. As President, Jeff approves and implements all business management decisions, runs all financials and budgeting and oversees the engineering, customer service, and marketing departments.

Compliance West USA prides itself on listening to its customers' needs and finding solutions to the challenges they face. These one-on-one customer relationships have enabled the company to enhance its products and capabilities on a consistent basis. Currently the company is introducing RS-232/USB connectivity across its line of surge and hipot testers, and offering custom test solutions to labs and companies worldwide through its domestic and international distribution network.

Compliance West, USA has become the most trusted name in hipot and surge testing equipment internationally for industries across the board, ranging from medical device manufacturing and telecom to computer technology and the solar energy market.

Jeff received his Bachelors of Science in electronic engineering from Cal Poly San Luis Obispo in 1976. A former downhill bicycle racer, Jeff enjoys biking and camping with his 8 year old twin sons.

(co-author)

JOSÉ CABANILLAS

has been with Compliance West, USA since 2005. He started out building testers for the company and was promoted to Engineering Manager in 2007. José is responsible for hardware design on new products and maintenance and improvement of existing designs.

Previously, José worked in Instituto Arangure as a Mathematics and Physics teacher in Tijuana B.C., Mexico from 2002 through 2004. He then worked as a Product Engineer at Sharp Electronics (SEMEX), in Rosarito, Mexico from 2004 through 2005.

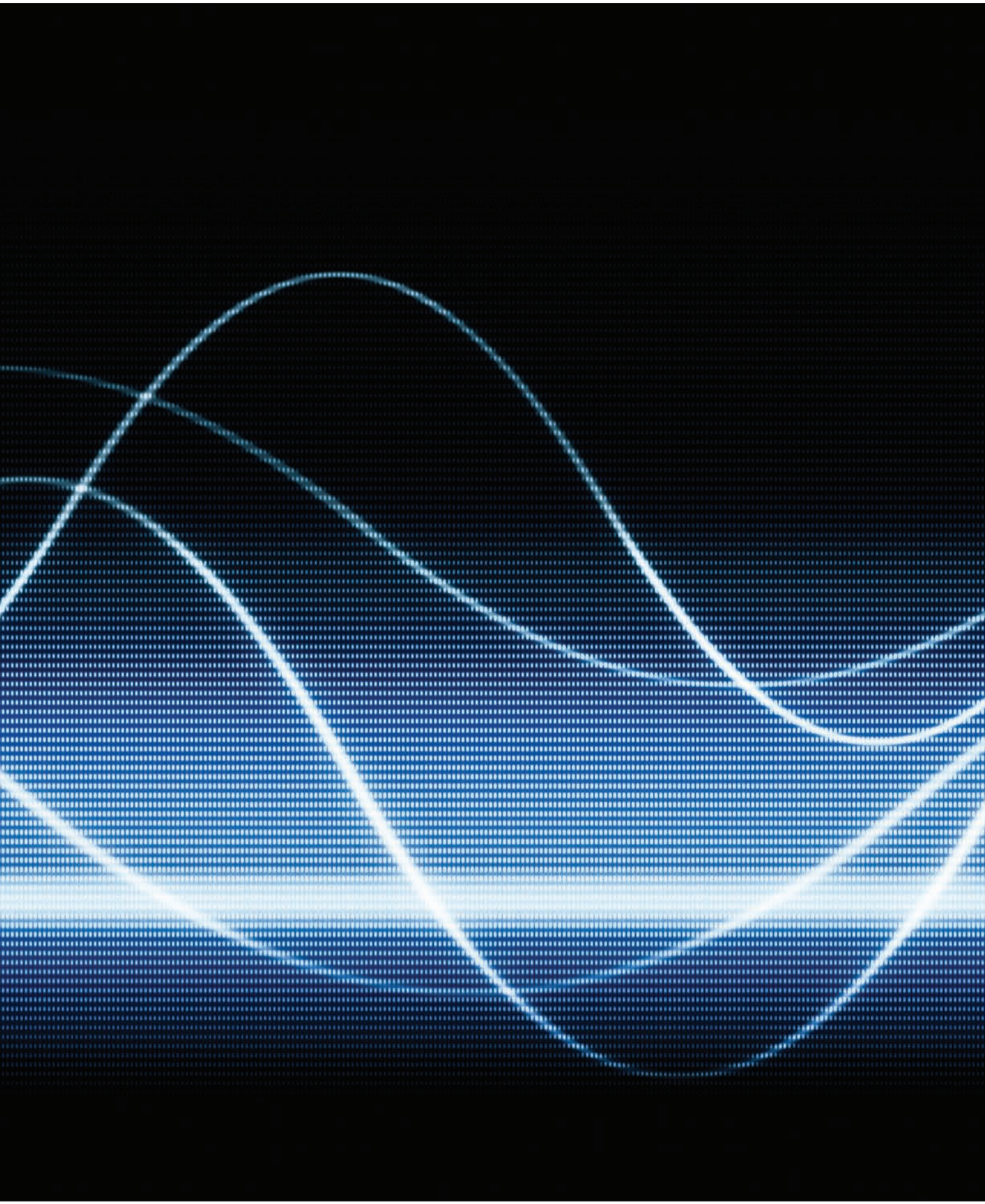
José received his Degree in Electronic Engineering from Instituto Tecnologico de Sonora, located in Cd. Obregon, Sonora, Mexico in 2002.

Surge Test Number	Min. Peak Open-Circuit Voltage	Min. Peak Short-Circuit current per conductor	Duration	Issue 5 Resistance	Resistance Needed on Issue 6	Difference	
2	425V	40A	1.5s	15 Ω	10.6 Ω	4.4 Ω	
3	425V	7A	5s	85.7 Ω	60.7 Ω	25 Ω	
4	425V	2.2A	15min	272.7 Ω	193.2 Ω	79.5 Ω	
4.3	425V	Adjusted (maximum 2.2A)	15min	272.7 Ω minimum	193.2 Ω minimum	79.5 Ω minimum	
5	425Vrms	N/A	15min	N/A	N/A	N/A	
6	425V	7A	5s	85.7 Ω	60.7 Ω	25 Ω	
7	425V	30A	5s	20 Ω	14.2 Ω	5.8 Ω	
8	425V	2.6A	15min	230.8 Ω	163.5 Ω	67.3 Ω	
8.1	425V	3A	15min	200 Ω	141.7 Ω	58.3 Ω	
8.2	425V	3.75A	15min	160 Ω	113.3 Ω	46.7 Ω	
8.3	425V	5A	15min	120 Ω	85 Ω	35 Ω	
8.4	425V	10A	5s	60 Ω	42.5 Ω	17.5 Ω	
8.5	425V	12.5A	5s	48 Ω	34 Ω	14 Ω	
8.6	425V	20A	5s	30 Ω	21.25 Ω	8.75 Ω	
8.7	425V	25A	5s	24 Ω	17 Ω	7 Ω	

Table 4: Table 4-5 Second-Level Power Fault Tests

	Comments
	This is considered a high power test. Normally fixed resistors are used for this tap. The 15 Ω resistor should be reduced by 4.4 Ω. The total power of the resistors should be rated for 17kW* for 1.5 seconds.
	This is considered a high power test. Normally fixed resistors are used for this tap. The 85.7 Ω resistor should be reduced by 25 Ω. The total power of the resistors should be rated for 2.98kW* for 5 seconds.
	This is considered a high power test. Normally fixed resistors are used for this tap. The 272.7 Ω resistor should be reduced by 79.5 Ω. The total power of the resistors should be rated for 935W for 15min. Because of the long duration of this test, it is recommended to use resistors that are rated continuous for the total rated power.
	At the 425V 2.2A tap. We can connect a rheostat in series, the resistance value will depend on the minimum current needed. The maximum power dissipated in the rheostat will be 233.75W for 15min. Because of the long duration of this test, it is recommended to use rheostats that are rated continuous for the total rated power.
	The components of the capacitors and transformer remains the same, it is just a lower voltage test.
	The tap of Surge Test 3 can be used for this test.
	This is considered a high power test. Normally fixed resistors are used for this tap. The 20 Ω resistor should be reduced by 5.833 Ω. The total power of the resistors should be rated for 12.75kW* for 5 second.
	This is considered a high power test. Normally fixed resistors are used for this tap. The 230.8 Ω resistor should be reduced by 67.3 Ω. The total power of the resistors should be rated for 1105W for 15min. Because of the long duration of this test, it is recommended to use resistors that are rated continuous for the total rated power.
	This is considered a high power test. Normally fixed resistors are used for this tap. The 200 Ω resistor should be reduced by 58.3 Ω. The total power of the resistors should be rated for 1275W for 15min. Because of the long duration of this test, it is recommended to use resistors that are rated continuous for the total rated power.
	This is considered a high power test. Normally fixed resistors are used for this tap. The 160 Ω resistor should be reduced by 46.7 Ω. The total power of the resistors should be rated for 1593.8W for 15min. Because of the long duration of this test, it is recommended to use resistors that are rated continuous for the total rated power.
	This is considered a high power test. Normally fixed resistors are used for this tap. The 120 Ω resistor should be reduced by 35 Ω. The total power of the resistors should be rated for 2125W for 15min. Because of the long duration of this test, it is recommended to use resistors that are rated continuous for the total rated power.
	This is considered a high power test. Normally fixed resistors are used for this tap. The 60 Ω resistor should be reduced by 17.5 Ω. The total power of the resistors should be rated for 4.25kW* for 5 seconds.
	This is considered a high power test. Normally fixed resistors are used for this tap. The 48 Ω resistor should be reduced by 14 Ω. The total power of the resistors should be rated for 5.31kW* for 5 seconds.
	This is considered a high power test. Normally fixed resistors are used for this tap. The 20 Ω resistor should be reduced by 5.833 Ω. The total power of the resistors should be rated for 8.5kW* for 5 seconds.
	This is considered a high power test. Normally fixed resistors are used for this tap. The 20 Ω resistor should be reduced by 5.833 Ω. The total power of the resistors should be rated for 10.63kW* for 5 seconds.

*Note: The dissipation power on most common resistors is ten times higher when used for 5 seconds or less. Refer to the resistor datasheet maximum overload specification. It is recommended to have a proper temperature control inside the test equipment.



Systems Response to Electrostatic Discharge
Part 1

Applications of impulse waveform research toward evaluation of product performance

BY W. MICHAEL KING

A NOTE FROM THE AUTHOR

The research references provided in this article occurred between 1978 and 1987, and are as applicable today as they were then, when they advanced understanding of ESD phenomena and through that, the ESD state of the art of knowledge.

These were the first reports to display that: ESD currents to a system do not increase in direct proportion to the initial electrostatic charge amplitude produced before the ESD event (e.g. low ESD voltages produce higher current than higher voltages); ESD spectra is greater than 1GHz with rise-times much faster than 1.0 nanosecond (e.g. 50 pSec to 200 pSec); the ESD "equivalent network" is not a single R-C network as previously thought, but rather a complex cascade of several networks, each with a different time constant; a "single ESD event" may be comprised of many events, even showing the approximate periodicity between each sub-event; suggested the initial impact of ESD was from boundary charge displacements of electric fields; detailed the ESD impulse waveforms and currents related to many common conditions (finger-tip direct, humans discharging through metal objects, humans discharging through furnishings); described how systems produce ESD amplitude-response dependencies owing to the different spectra of ESD events at different amplitudes; and, that compliance with a higher amplitude of ESD (e.g. 15kV) does not assure that adequate immunity will be exhibited at lower (e.g. 2kV) levels. During these research efforts the "human body concept", the "human with metal object" concept; the "furnishings impact" equivalent values; the vertical and horizontal coupling planes for "radiated ESD equivalents" were all devised. The impact on the international community was sufficiently extensive starting circa 1979 that approximately five years of confirming work were required for the reports to achieve broad acceptance.

Since that time this work has been thoroughly disseminated and various standards and standard practices for ESD have been published, many (if not most) of which extend from these early research efforts. In the process of standardization some of the baseline foundational information delineating ESD mechanisms have been diffused. It didn't help that when the IEEE converted published symposia archives to microfiche some years ago, much of the original photographic data for ESD event waveforms was lost as the contrast of the original printed publications became often degraded to black rectangles. Thanks to the invitation of The Editor of this magazine, you have the opportunity to travel with me, back to history, and back to this future to gather a broad understanding of the underlying boundary charge displacements that establish ESD, catch a glimpse of the propagational spectral mechanisms that impact systems-product performance, and to review foundational information that extends to this day.

W. Michael King

(For further reading, I suggest the book "Electrostatic Discharge" Third Edition by Michel Mardiguian, Wiley/IEEE Press, ISBN: 978-0470-39704-6, and ANSI, C-63.16-1994 "Guide for Electrostatic Discharge Test Methodologies and Criteria for Electronic Equipment.")

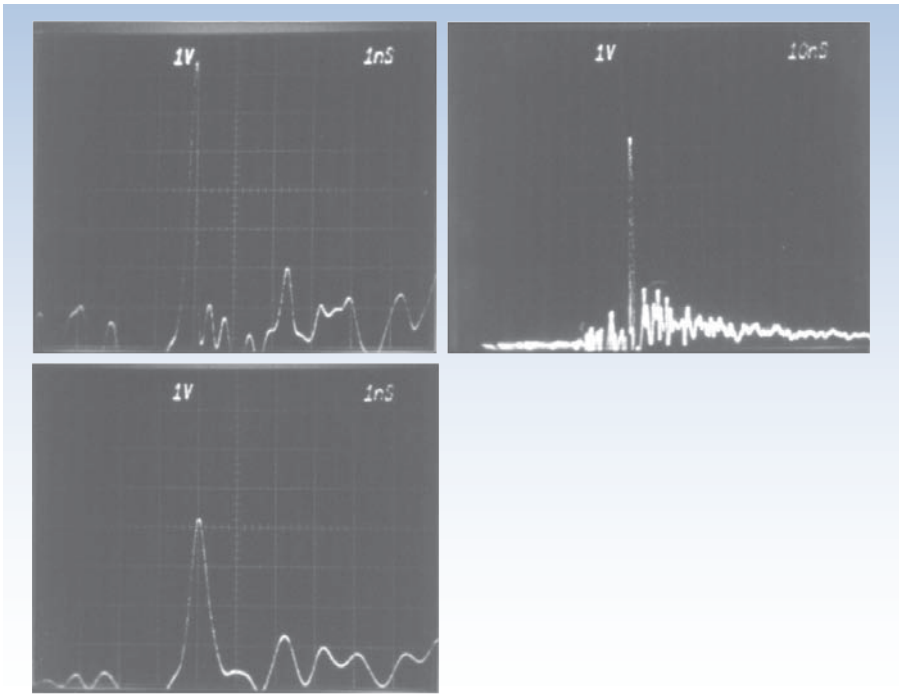


Figure 1a: ESD Impulse Waveform Distribution: Human with Metallic Object; 2,000 Volts Initialization.
Scale: 10 Amperes/Division. Displayed: 42 Amperes to 74 Amperes
(Tr = 200 pSec; Tf = 50 pSec)

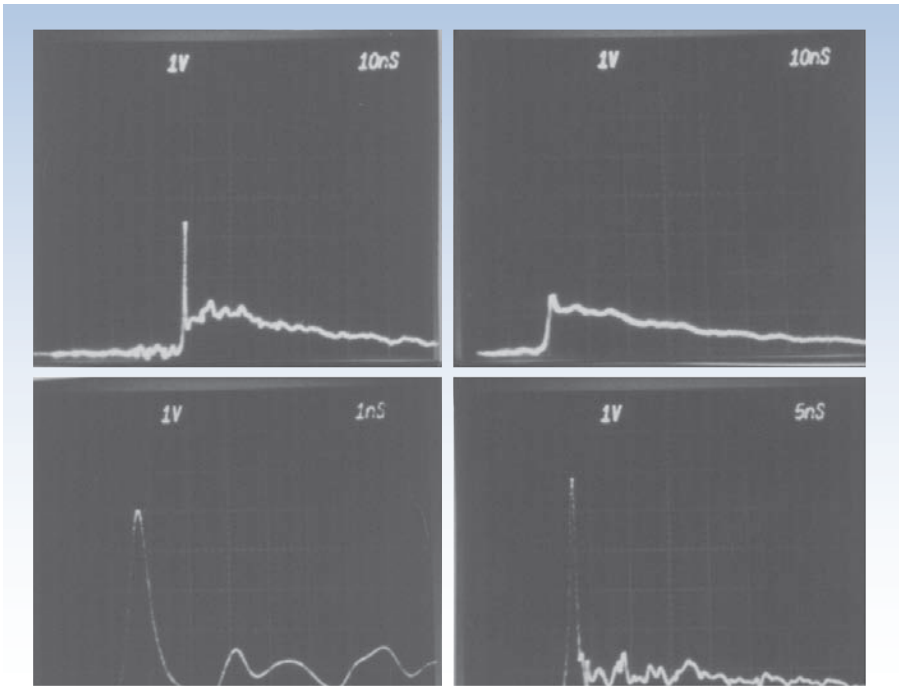


Figure 1b: ESD Impulse Waveform Distribution: Human with Metallic Object; 4,000 Volts Initialization.
Examples of event-to-event distribution in nature
Scale: 10 Amperes/Division. Displayed: 15 Amperes to 58 Amperes

In recent years, various research results have been published that define (for the first time) the true complexity of dynamic impulse waveforms developed through personnel electrostatic discharge (ESD) events (see reference list). These research studies have contributed significantly toward understanding the ESD susceptibility response mechanisms exhibited by systems products that previously were considered to be "mysterious".

Examples of such system responses are performance criteria failing at low ESD initialization levels (<2 kV) and complying at higher levels (>7 kV), or complying at low initialization levels failing at intermediate levels (5 to 7 kV) and complying at higher levels (>10 kV).

This paper discusses the application of ESP impulse waveform research results toward understanding the ESD amplitude-waveform dependency of susceptibility responses from systems products, and outlines the conceptual aspects of the test methodology required for thorough product evaluation.

BACKGROUND

During the time frame of 1978 through 1983, an experimental measurement series to determine the ESD waveform continuum was performed, with results published in various forums [1, 3 and 4]. Further work that tended to confirm the earlier results continued into 1986 [6]). The results of these experimental measurements indicated:

a. The dynamic waveform continuum of ESD events exhibited exceptionally high bandwidths of spectral level distribution at low ESD initialization levels [<5 kV] extending into the microwave domain, with risetimes measured and reported as fast as 200 picoseconds (See Figure 1);

b. The spectral bandwidths of ESD resulting from higher initialization levels (>10 kV, <20 kV) ranged in

the tens to hundreds of megahertz, with risetimes in the order of 4 nanoseconds to several tens of nanoseconds (See Figure 2). The spectral bandwidths of ESD initialization levels between these two extremes were found to range in between, with risetimes in the one to ten nanosecond range (See Figure 3, page 46);

c. There are vast differences in ESD peak current delivered (as impulse intensity) to a product when a human discharge occurs from a finger-tip as compared to a human holding a metallic object (key, coin, pen, tool). See Figure 4, page 47.

Independently worked from a theoretical approach, studies by William Byrne, then Senior Scientist at the Southwest Research Institute (in San Antonio, TX), generally provided theoretical confirmation of the previously described experimental results [2 and 5].

The experimental test methods developed to determine the ESD waveforms as described in the referenced research efforts have been utilized broadly in the international technical community, and form the basis of capital ESD publications of the International Electrotechnical Commission (IEC).

Based on the information provided through the research efforts noted above, a thorough understanding of systems response to ESD events becomes possible. When combined with these applications of impulse waveform research, an approach to comprehensive evaluation of product and systems performance during ESD event exposure is extrapolated.

ESD IMPULSE PROPAGATION

The propagation of ESD impulse current in a product or system is significantly influenced by the distributed common-

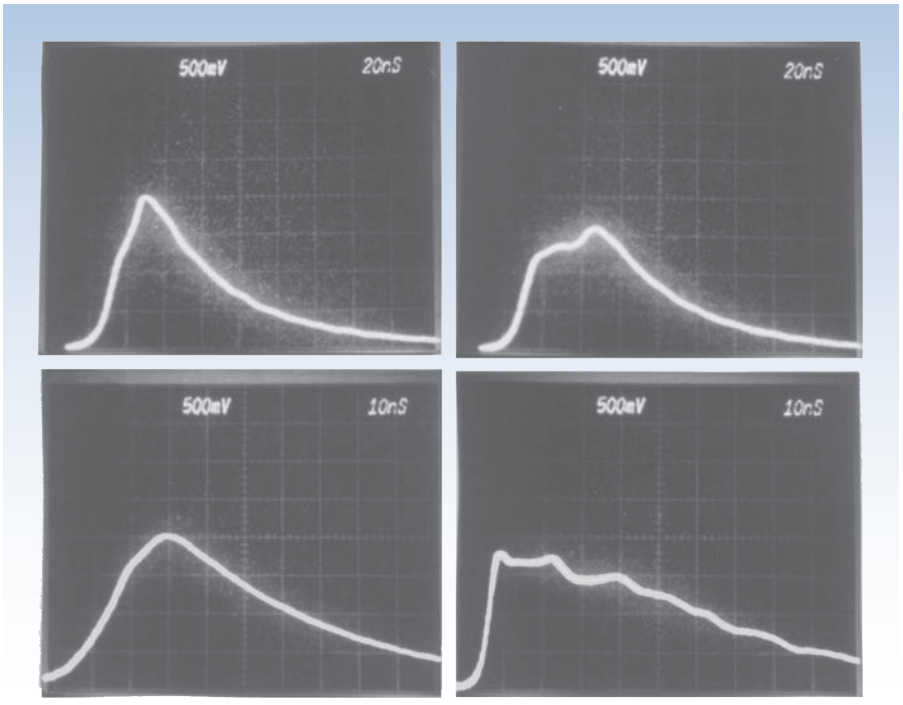


Figure 2a: ESD Impulse Waveform Distribution: Human with Metallic Object; 10,000 Volts Initialization.
Examples of event-to-event distribution in nature
Scale: 5 Amperes/Division. Displayed: 16 Amperes to 20 Amperes

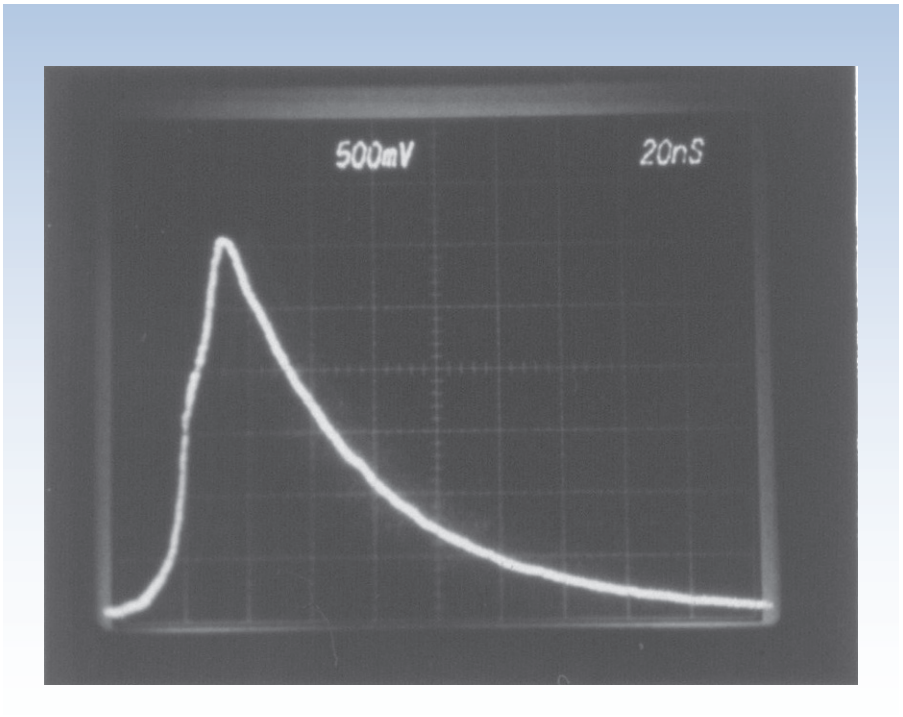


Figure 2b: ESD Impulse Waveform Example: Human with Metallic Object; 20,000 Volts Initialization
Scale: 5 Amperes/Division: Displayed: 31 Amperes

The distributed transfer impedance of a unit above the reference (ground) is paralleled by the ground wire connection in the primary AC power cable, as well as the power lines themselves.

mode impedance magnitude of the product/system's structure relative to external ground surfaces. Usually, these dynamic reference transfer impedances are simply referred to as being "coupled to ground", although spatially they may also couple/propagate to structures that are immediately adjacent to the product being subjected to the ESD event. (When the ESD is applied to a STRUCTURE that is immediately adjacent to the product under evaluation, a radiated field displacement occurs through these same distributed transfer impedances, causing (potentially) a form of radiated susceptibility.)

The distributed transfer impedance of a unit above the reference (ground) is paralleled by the ground wire connection in the primary AC power cable, as well as the power lines themselves. The combined product-level impedance that is ultimately transferred to "ground" as represented by these segments is, in turn, paralleled by the distributed and direct impedance of any interface cables that are connected to the product under evaluation. (This is because the interface cables, in themselves, are referenced [coupled] to "ground", and the interfaced product/system that is eventually connected to the opposite end of the interface cables are probably connected to "ground" through other primary AC power cables.) [7].

It may be recognized that the two axis of distributed transfer impedances (to ground and literally to adjacent structures) mutually share the ESD impulse currents within impedances that develop in the interface cables to ground and to other equipment. Further, these two axis provide current sharing interactions with the references yielded through the AC power cables.

Given the propagation of ESD energy via these multiple paths, it can be recognized that the magnitude of the ESD impulse current that circulates in the interface cables (entering or a exiting the product) must be influenced by the characteristics of the distributed transfer impedance of the product above ground. In other words, the lower the value of distributive transfer impedance formed between a

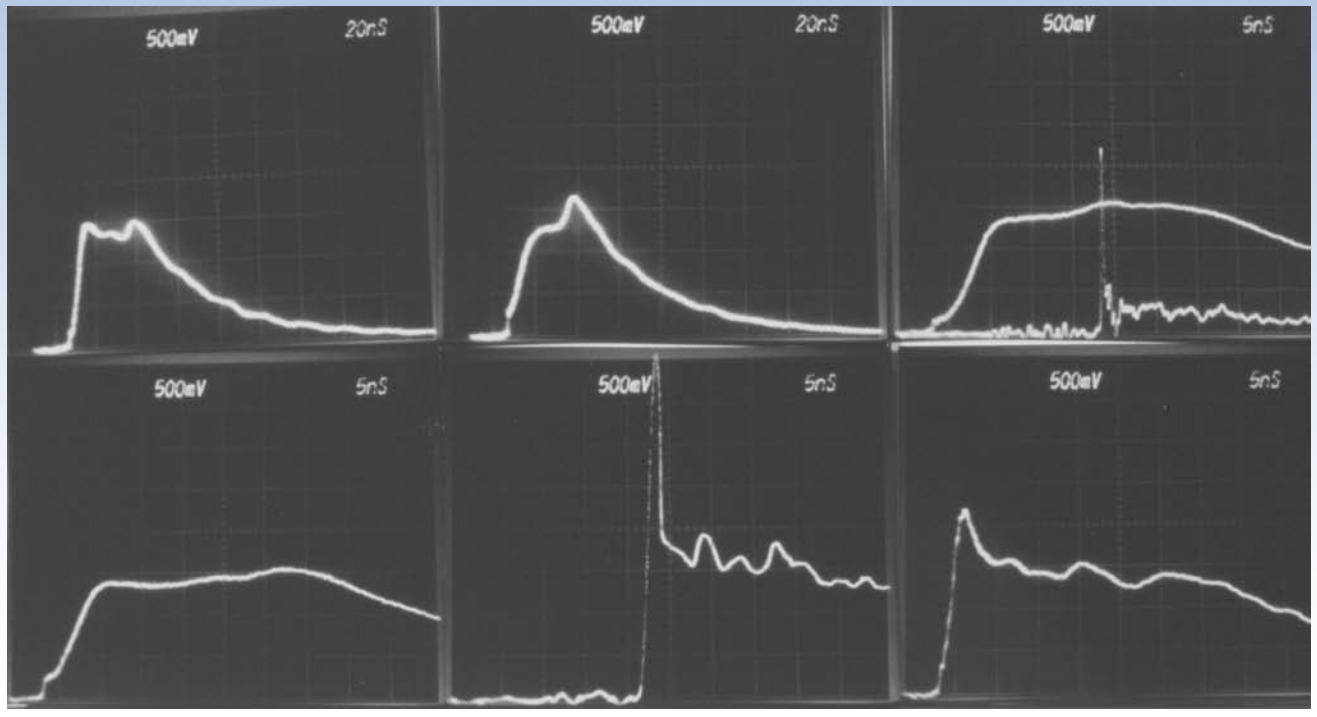


Figure 3: ESD Impulse Waveform Distribution: Human with Metallic Object; 8,000 Volts Initialization Scale: 5 Amperes/Division: Displayed 15 Amperes to 40 Amperes.

The lower the value of distributive transfer impedance formed between a product and ground, the higher value of impulse current will flow through the distributive vehicle, and lower will be the relative value of impulse ESD current that will propagate through the interface or power cables.

product and ground, the higher value of impulse current will flow through the distributive vehicle, and lower will be the relative value of impulse ESD current that will propagate through the interface or power cables.

With these interactions of the ESD propagational "sharing" through impulse propagational references directed through the various paths noted above, substantial ESD performance (susceptibility) variances are encountered by altering the distributed impedance parameters of products through conditional/installation means. Such would be the effect, for example, of encountering ESD susceptibility response variations from a desk-top unit by placing the unit on a metal desk versus placing the unit on a non-conductive wooden desk.

This variable-response effect is brought about because the lower distributive transfer impedance provided to the unit (to "ground") through the metal desk will, in execution:

a. Move ESD energy away from the interface and power cables, resulting in less potential interface susceptibility because there will be reduced ESD current/energy propagated in the interface (and power) cables.

b. Intensify the ESD current in the case and cabinet structures of the unit that are coupled to ground through distributive means, thereby increasing the potential for ESD susceptibility effects from case-derived (shielding or slot aperture) causes.

Accordingly, the potential of ESD performance variations available for smaller (desk-top or handheld) units may be far greater in terms of both ESD amplitude thresholds, and response characteristics, than those potential variations that may be exhibited for a larger system or floor-standing unit, in that the relative impedance ratios between the interface impedance

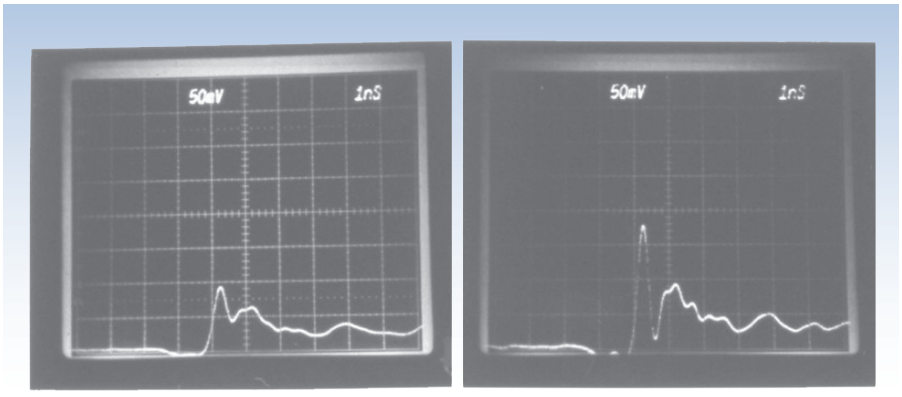


Figure 4a: ESD Impulse Waveform From Human Finger-tip: 500 Volts Initialization Scale: 0.5 Amperes/Division. Displayed: 0.9 Amperes to 1.8 Amperes; (Tr = 200 pSec)

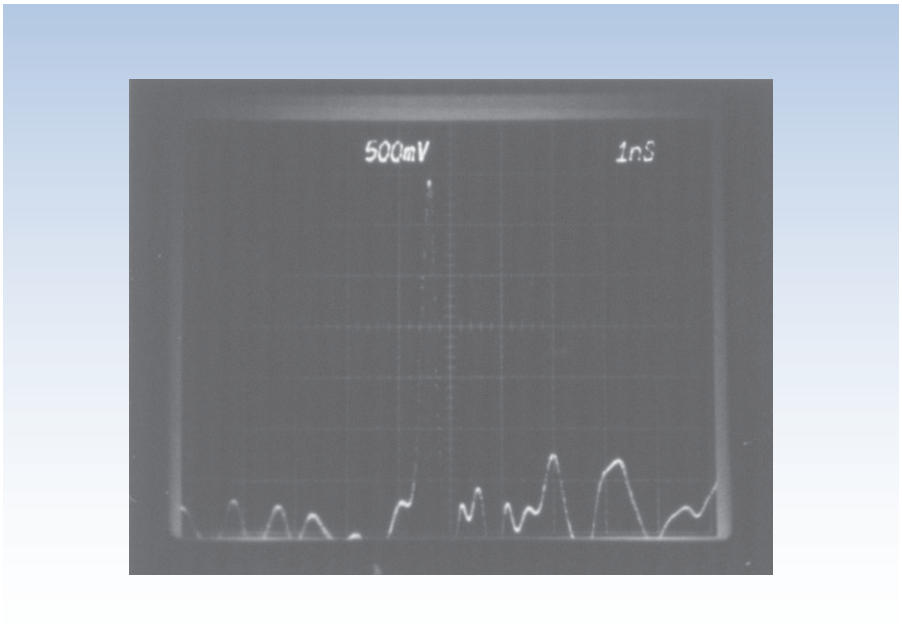


Figure 4b: ESD Impulse Waveform, Human with Metallic Object: 500 Volts Initialization Scale: 5.0 Amperes/Division. Displayed: 34 Amperes
(COMMENT: The metal object condition yields 19:1 Greater Current than Finger-tip condition).

These same interactions are responsible for variations in the ESD susceptibility performance of products with remote keyboards if the ESD impulses are applied to the "remote" keyboard when it is supported above a non-conductive desk while the "host" product is above a common conductive support plane.

paths and the distributive (structural) impedance is potentially more variable for the desk-top supported or hand-held unit.

On a unit level, these same interactions are responsible for variations in the ESD susceptibility performance of products with remote keyboards (or hand-held devices) if the ESD impulses are applied to the "remote" keyboard when it is supported above a non-conductive desk while the "host" product is above a common conductive (desk) support plane. The ESD impulse transfers in the keyboard cable will be significantly altered by execution of these relatively simple installation condition changes. IN

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(*) The Vertical Coupling Plane (VCP), Horizontal Coupling Plane (HCP), Incremental Level Test Requirements and incremental probability criteria were first devised and presented in these (and similar) documents.

(**) Note: This article is based on, and is an expansion of, the above published paper.

Look for Part 2 of this article in the January 2012 issue.

(the author)

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is a systems design advisor who has been active in the development of over 1,000 system-product designs in a 50 year career. He serves an international client base as an independent design advisor. Many terms used for PC Board Layout, such as the "3-W Rule", the "V-plane Undercut Rule", and "ground stitching nulls", were all originated by himself. His full biography may be seen through his web site: www.SystemsEMC.com.

Significantly, he is the author of EMCT: High Speed Design Tutorial (ISBN 0-7381-3340-X) which is the source of some of the graphics used in this presentation. EMCT is available through Elliott Laboratories/NTS, co-branded with the IEEE Standards Information Network.

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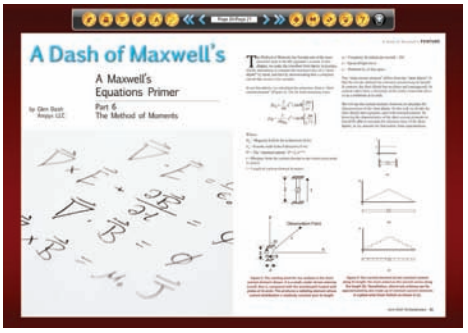

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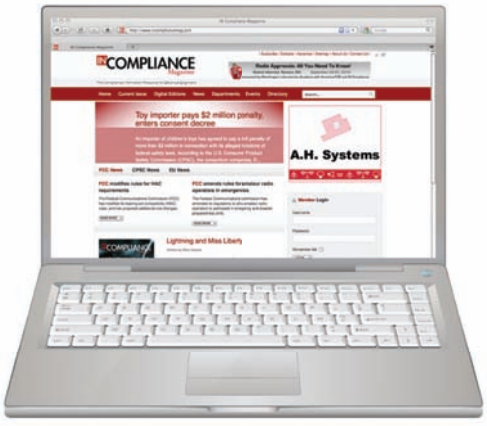

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A Historical Look Back: The 1977 CBEMA Paper on Electromagnetic Emanations

Part 2

The first part of this paper reviewed the first one-third of the report including the Title of the Paper, the Background to its development, the Members of the Subcommittee that developed the report, Definitions, Table of Contents, Scope and Section 4. This second part of the paper will look at Section 5 (Susceptibility of Communications Receivers to Commercial EDP/OE Emanations) of the Report.

BY DANIEL D. HOOLIHAN

In the middle of the 1970s, the United States Federal Communications Commission (FCC) began to look seriously at electromagnetic emissions from electronic data processing (EDP) equipment and office equipment (OE). This growing awareness on the part of the United States telecommunications regulation body was a result of the increasing number of computers being used by society and the increased potential for growth by licensed broadcast services due to the proliferation of electronic-computer sources. The Computer and Business Equipment Manufacturers Association (CBEMA) formed a technical subcommittee to assist in preparing an industry response to the concerns of the FCC.

TITLE OF PAPER

The title of the published paper was *Limits and Methods of Measurement of Electromagnetic Emanations from Electronic Data Processing and Office Equipment*. The report was prepared by Subcommittee 5 on Electromagnetic Interference, which was organizationally part of the Environment and Safety Committee of CBEMA.

A
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Section 5 of the 183 page report investigated the universe of principal communication services in the Unites States of America.

TABLE OF CONTENTS

The 183 page report included a Title Page, Foreword, Table of Contents, Scope, Definitions, Introduction, seven major sections, Conclusion, and one Appendix.

The seven major sections were:

- Section 4 – Electronic Data Processing and Office Equipment as a Source of Electromagnetic Emanations
- Section 5 – Susceptibility of Communication Receivers to Commercial EDP/OE Emanations
- Section 6 – Interference Potential of EDP/OE
- Section 7 – The Commercial EDP/OE Interference Models
- Section 8 - Emanation Limits for EDP/OE Products
- Section 9 – Comparison of Recommended Limits with Others
- Section 10 – Emanation Measurement

SECTION 5

Susceptibility of Commercial Receivers to Commercial EDP/OE Emanations

This section of the report investigated principal communication services in the Unites States of America. It divided services into two sections: low frequency-high frequency (LF-HF)

Frequency - kHz	Service
10 – 200	Radionavigation, International Fixed Public, Maritime
200 – 535	Aeronautical, Maritime
535 – 1605	Amplitude Modulation (AM) Radio Broadcast
1605 – 1800	Aeronautical, Industrial, International Fixed Public, Maritime, Public Safety
1800 – 2000	Amateur
2000 – 2107; 4063 – 4438; 6200 – 6525; 8195 – 8815; 12330 – 13200; 16460 – 17360; 22000 - 22720	Maritime
2107 - 4063	Aeronautical, Industrial, International Fixed Public, Maritime, Public Safety, Amateur, Radio Astronomy
4438 – 5950; 9775 - 11700	Aeronautical, Industrial, International Fixed Public, Radio Astronomy
5950 – 6200; 9500 – 9775; 11700 – 11975; 15100 - 15450	International Broadcast
6525 – 8195; 8815 - 9500	Aeronautical
11975 – 12330; 15450 - 16460	Aeronautical, International Fixed Public
13200 - 15100	Aeronautical, International Fixed Public, Radio Astronomy, Amateur
17360 - 22000	Aeronautical, International Fixed Public, International Broadcast, Amateur
22720 - 30000	Aeronautical, International Fixed Public, International Broadcast, Amateur, Industrial, Civil Air Patrol, ISM

Table 1

Interference to a receiver has both objective (technical) criteria and subjective (human differences) criteria.

and very high frequency-ultra high frequency (VHF-UHF).

Though not all services were studied, those that had the greatest potential for interference due to the sensitivity or number of their receivers were studied in great detail. Receiver populations and antenna density adjacent to electronic data processing/office equipment centers was carefully studied and reported on in Section 6 of the report. Receiver frequency selectivity and "electrical noise" tolerance were also investigated.

Furthermore, Section 5 looked at the derivation of signal-to-noise (S/N) ratios and the interference criteria for narrowband (NB) and broadband (BB) receiver responses.

Table 1 shows the Federal Communication Commission (FCC) frequency allocations in the LF-HF range in 1977.

Examples of VHF-UHF (30 MHz to 300 MHz) services include: government, public safety, industrial, transportation, amateur, television (TV), operational fixed, radio astronomy, aeronautical navigation, broadcast frequency modulation (FM) radio, airdrome control, aeronautical mobile, space research, maritime mobile, land fixed mobile, TV and FM links, and industrial, scientific and medical (ISM).

Receiving devices in the VHF-UHF range had common technical characteristics such as detector type, intermediate frequency (IF), bandwidth sensitivity, antenna type, and antenna polarization. The VHF-UHF range was divided into ten bands in Table 5.3 of the report and the bands were used to develop emanation limits with respect to receivers in those bands.

Typical received and recommended FCC field strengths in the AM radio band (535 to 1605 kHz) were listed in Table 5.4 in the report, as duplicated in Table 2.

A similar table was generated for the TV bands encompassing 54 – 88 MHz, 174 – 216 MHz, and 470 – 890 MHz. Similarly, other field strengths were analyzed for the remaining communication services in the study.

A communications receiver's susceptibility to electromagnetic signals is determined by two major factors: its frequency selectivity as gauged by its bandwidth and its amplitude sensitivity as gauged by its signal-to-noise ratio (S/N).

Reciever interference has both objective (technical) criteria and subjective (human differentiation) criteria. If multiple lines of energy are captured by the bandwidth of a receiver (in addition to the intended signal), the resultant "interference" sound like buzzing and popping on an AM radio band. If a single line of energy is captured in conjunction with the intended signal, a herringbone pattern may be displayed on a TV screen. The report clearly deferentiated between the two types of interference; the first being broadband (multiple lines of energy) and the second being narrowband (single line of energy). The physiological response of the human eye and ear varies from human to human. No single EMI receiver could duplicate all the various communication receivers in existence, so the report used the following criteria: a pulse repetition rate (PRR) of greater than 1000 pulses per second would be narrowband for the study, and a PRR of greater than 100,000 pulses per second would be narrowband for radiated emissions. PRRs of less than those values would be considered broadband.

Population	Field Strength – dBμV/meter
Up to 2500	54
2500 – 10,000	66
>10,000 – City-Business, Factory Area	80 - 94
>10,000 – City – Residential	60 - 80
>10,000 - Rural	40 - 60

Table 2

Radio Frequency (RF) sine wave generators and square wave generators were used to simulate the EDP/OE emissions under controlled laboratory conditions.

Signal-to-noise ratios of receivers were collected from available literature for most receivers in the report. The thresholds of detectable interference (TDI) were generated by critical listeners and observers. The TDI and corresponding field strength level were used to calculate either the peak or quasi-peak S/N ratio for use in the radiated model, or the TDI was used directly in the conducted model.

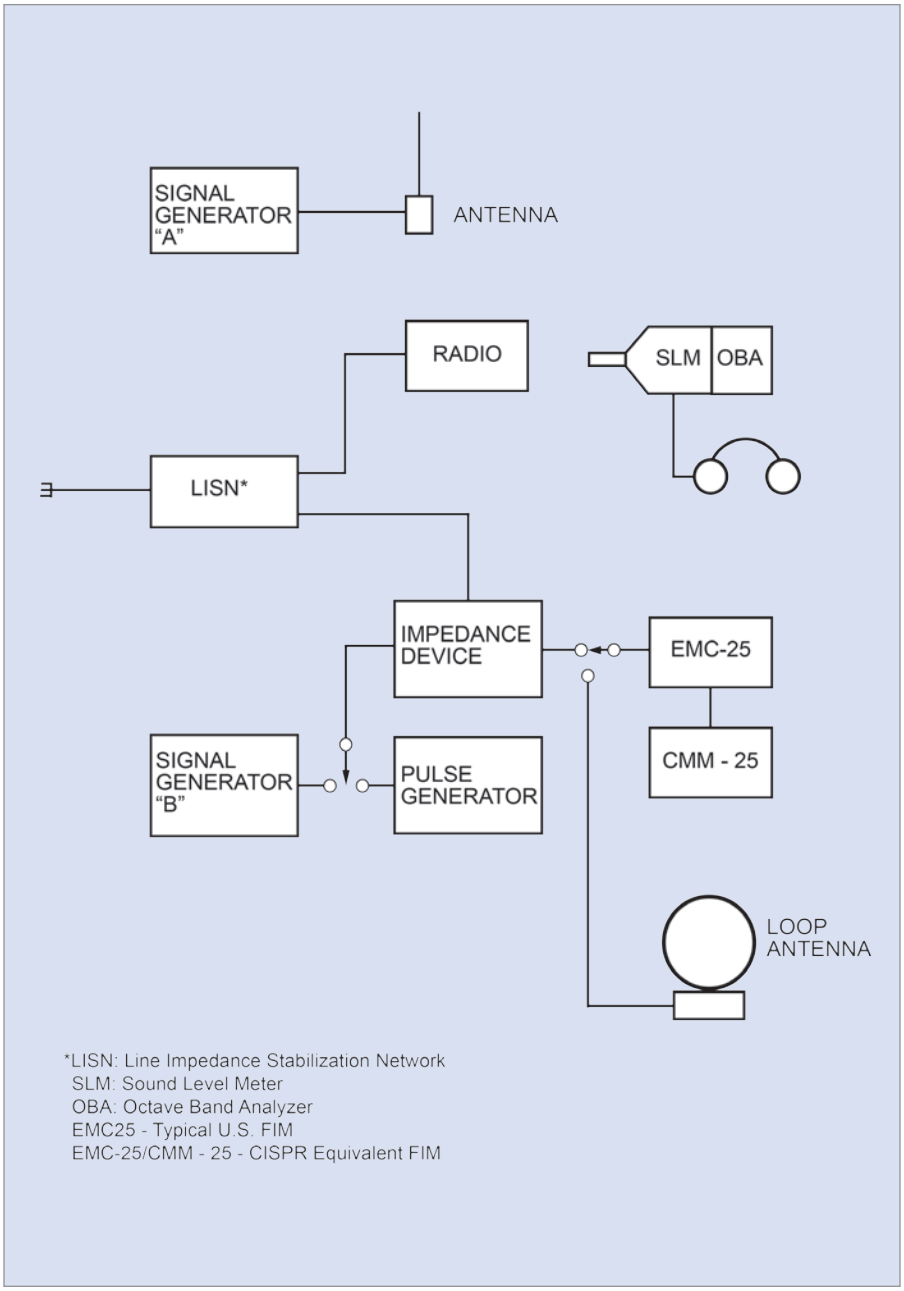

Figure 1: Figure 5-2 from the study

In the empirical part of the report, it was decided that actual EDP/OE equipment would not be used because its signal amplitudes could not be adjusted to search for receiver noise thresholds. Therefore, radio frequency (RF) sine wave generators and square wave generators were used to simulate the EDP/OE emissions under controlled laboratory conditions.

Audio TDIs of AM radio receivers were determined in a low-audio ambient environment (40 – 45 dBA); approximately 45 receivers were evaluated. The receivers were tuned to 1 MHz and the carrier was modulated with a 1 kHz audio tone (1 kHz was selected because it is in the most sensitive region of the human ear). The BB audio output of the radios was found to be somewhat independent of the pulse width so a pulse width was selected to produce a nearly uniform spectral amplitude throughout the passband of the receiver at the chosen carrier frequency. Both the NB and BB distributions of the TDI for the receivers studied were identified as "normally distributed". When the carrier was modulated with actual music or voice, the threshold of detectable interference was 6 dB greater than the RF source level. An audio masking factor of 9 db was used for NB signals and 8 dB for BB signals.

For the case of a radio with an ungrounded neutral for the radio, a worst-case factor of 6 dB was assumed.

Published S/N ratios for TV also were researched for the report. Accepting

Section 5 provided a detailed summary of the primary communication services in the USA and typical received field strengths under defined conditions.

a Grade 3 quality picture (as defined by TASO – the Television Allocation Study Organization) as the standard, a 45 dB S/N tolerance was used for a narrowband source. Due to lack of information in the literature of the day, an empirical study for BB interference was done using 34 TV receivers. The observed TDI was highly dependent on the PRR. It was noted, among other conclusions of the BB study, that color TV sets were more sensitive than Black and White TV sets. In general, S/N ratios for other communication receivers were found in the literature and used in the report.

The method used by the 1977 study for developing BB peak and quasi-peak EMI limits was based on consideration of the empirically determined TDI levels (which are PRR dependent) evaluated at the selected BB pulse repetition rates for each of the services.

Table 5-13 in the study summarized the BB signal-to-noise ratios that were used in the development of the BB limits in Section 8 of the report. A portion of Table 5-13 is reproduced in Table 3.

SUMMARY

Section 5 provided a detailed summary of the primary communication services in the USA (along with their allocated frequencies) and typical received field strengths under defined conditions. The response of a receiver to EDP/OE emanations is a function of pulse repetition rates (PRRs), S/N ratios, and receiver bandwidths. The PRRs determined whether the interference was narrowband or broadband. The result of the studies and empirical data generated in this section provide a measure for TDI relative to broadband and narrowband sources. A "transition PRR" is acknowledged where the observable effects change from BB to NB. The analysis was performed for conducted emissions from 450 kHz to 30 MHz and for radiated emissions from 30 MHz to 1000 MHz. IN

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is the Founder and Principal of Hoolihan EMC Consulting. He is a Past-President of the EMC Society of the IEEE and is presently serving on the Board of Directors. He is presently an assessor for the NIST NVLAP EMC and Telecom Lab Accreditation program. Also, he is the Vice-Chair of the ANSI ASC C63® committee on EMC.

Primary Service	Band	Frequency MHz	Primary Grade Signal Strength dBµV/m	Quasi-Peak		Peak	
				Empirical TDI dBµV/m	S/N Ratio dB	Empirical TDI dBµV/MHz/m	S/N Ratio dB
Public Safety	1	Low VHF 30 -54 MHz	31	26	+5	43	-12
	5	High VHF 100 -174 MHz	37	29	+8	47	-10
	9	UHF 420-470	39	-	+8**	-	-10**
TV	2	Low VHF 54 – 88 MHz	68	15*	53	31*	+37
	6	High VHF 174 – 216	71	29*	42	40*	+31
	10	UHF 470 - 1000	74	-	42**	-	+31**

* Includes perception shift from Table 5-9 which normalizes data for a non-expert reviewer

** Signal-to-noise ratio from adjacent, like service with empirical data

Table 3

ESD Standards: An Annual Progress Report

BY THE ESD ASSOCIATION

Industry standards play a major role in providing meaningful metrics and common procedures that allow various manufacturers, customers and suppliers to communicate from facility to facility around the world. Standards are increasingly important in our global economy. In manufacturing, uniform quality requirements and testing procedures are necessary to make sure that all involved parties are speaking the same language.

In electrostatic discharge (ESD) device protection, standard methods have been developed for component ESD test models to measure a component's sensitivity to electrostatic discharge from various sources. In ESD control programs, 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 protection and avoidance. The ESD Association is an American National Standards Institute (ANSI) accredited standards developer. The ESDA's consensus body, called the Standards Committee (STDCOM), has responsibility for the overall development of documents. Volunteers from the industry participate in working groups to develop new and to update current ESDA documents.

STDCOM is charged with keeping pace with the industry demands for increased performance. The existing Standards, Standard Test Methods, Standard Practices and Technical Reports assist in the design and monitoring of the Electrostatic Protected Area (EPA), and also assist in the testing of ESD sensitive electronic components. Many of the existing documents relate to controlling electrostatic charge on personnel and stationary work areas. However, with the ever increasing emphasis on automated handling, the need to evaluate and monitor what is occurring inside process equipment is growing daily. Since automation has become more dominant, the Charged Device Model (CDM) has become the primary cause of ESD failures and thus the more urgent concern. Together the Human Body Model (HBM) and CDM cover the vast majority of ESD events that might occur in a typical factory.

ESD Association Document Categories

- **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 may not be 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.

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- **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 ESDA Technology Road Map is compiled by industry experts in IC protection design and testing to provide a look into future ESD design and manufacturing challenges. The roadmap previously pointed out that numerous mainstream electronic parts and components would reach assembly factories with a lower level of ESD protection than could have been expected just a few years earlier. This prediction has proven to be rather accurate. As with any roadmap, the view to the future is constantly changing and requires updating on the basis of technology trend updates, market forces, supply chain evolution and field return data. Work has commenced on the next version. Industry experts will be extending the horizon beyond 2013 predictions in the updated roadmap. The roadmap will also contain, for the first time, a roadmap for the evolution of ESD testing. This will include forward looking views of possible changes in the standard device level tests (HBM and CDM), as well as the expected progress in other important areas such as transmission line pulsing (TLP), transient latch-up (TLU), cable discharge events (CDE) and charged board events (CBE). A view of work on electrical overstress (EOS) will also be included. The revision is scheduled for publication in January 2012.

The ESD Association Standards Committee is continuing several joint document development activities with the JEDEC Solid State Technology Association. Under a Memorandum of Understanding agreement, the ESDA and JEDEC formed a Joint Task Force for standardization work in which volunteers from ESDA and JEDEC member companies can participate. This collaboration between the ESDA and JEDEC has paved the way for the development of harmonized test methods for ESD, which will ultimately reduce uncertainty about test standards among manufacturers and suppliers in the solid state industry. At the time of this publication, ANSI/ESDA/JEDEC JS-001-2011, a second revision of the joint HBM document, has been released for distribution. This document replaces ANSI/ESDA/JEDEC JS-001-2010, the current industry test methods and specifications for HBM device testing. A second joint committee is currently working on a joint CDM document with a goal of publishing in 2012. These efforts will assist manufacturers of devices by providing one test method and specification instead of multiple, almost (but not quite) identical versions of device testing methods.

The ESDA is also working on a process assessment document. The purpose of this document is to describe a set of methodologies, techniques and tools that can be used to characterize a process where ESD sensitive items are handled. The goal is to characterize the ability of a process to safely handle ESD sensitive devices that have been characterized by the relevant device testing models. The document will apply to activities that manufacture, process, assemble, install, package, label, service, test, inspect, transport or otherwise handle electrical or electronic parts, assemblies and equipment susceptible to damage by electrostatic discharges. At the present time, this document will not apply to electrically-initiated explosive devices nor flammable liquids or powders.

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 and replacement for 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. A five-year review of ANSI/ESD S20.20 began in February 2011 and technical changes are being made to the document based on industry changes and user requests. There are unique constraints with the revision that must be taken into account, including facility certification and continued harmonization with other standards (IEC 61340-5-1 and newly revised JEDEC 625B). A target date of February 2012 has been given for the release of a draft document.

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 ESDA through country-accredited ISO9000 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. More than 384 facilities have been certified worldwide since inception of the program. The Factory Certification bodies report strong interest in Certification to S20.20, and consultants in this area report that inquiries for assistance remain at a very high level. Individual education also seems of interest once again as 46 professionals have obtained Certified ESD Program Manager status and many more are attempting to qualify as Certified ESD Control Program Managers. A large percentage of the certification program requirements are based on the Standards and other related documents produced by the ESD Association Standards Committee.

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.

CURRENT ESD ASSOCIATION STANDARDS COMMITTEE DOCUMENTS

Charged Device Model (CDM)

ANSI/ESD S5.3.1-2009 Electrostatic Discharge Sensitivity Testing - Charged Device Model (CDM) - Component Level
Establishes the procedure for testing, evaluating and classifying the ESD sensitivity of components to the defined CDM.

Cleanrooms

ESD TR55.0-01-04 Electrostatic Guidelines and Considerations for Cleanrooms and Clean Manufacturing
This document identifies considerations and provides guidelines for the selection and implementation of materials and processes for electrostatic control in cleanroom and clean manufacturing environments.

Compliance Verification

ESD TR53-01-06 Compliance Verification of ESD Protective Equipment and Materials
This technical report describes the test methods and instrumentation that can be used to periodically verify the performance of ESD protective equipment and materials.

ESD Control Program

ANSI/ESD S20.20-2007 Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
This standard provides administrative and technical requirements for establishing, implementing and maintaining an ESD Control Program to protect electrical or electronic parts, assemblies and equipment susceptible to ESD damage from Human Body Model (HBM) discharges greater than or equal to 100 volts.

ESD TR 20.20-2008—ESD Handbook (Companion to ANSI/ESD S20.20)
Produced specifically to support the ANSI/ESD S20.20 ESD Control Program Standard, this 132-page document is a major rewrite of the previous handbook. It focuses on providing guidance

that can be used for developing, implementing and monitoring an ESD control program in accordance with the S20.20 Standard.

Flooring

ANSI/ESD S7.1-2005 Resistive Characterization of Materials – Floor Materials
Covers measurement of the electrical resistance of various floor materials, such as floor coverings, mats and floor finishes. It provides test methods for qualifying floor materials before installation or application, and for evaluating and monitoring materials after installation or application.

Flooring and Footwear Systems

ANSI/ESD STM97.1-2006 Floor Materials and Footwear – Resistance Measurement in Combination with a Person
Provides test methods for measuring the electrical system resistance of floor materials in combination with a person wearing static control footwear.

ANSI/ESD STM97.2-2006 Floor Materials and Footwear – Voltage Measurement in Combination with a Person
This standard test method provides for measuring, as a system, the electrostatic voltage on a person in combination with floor materials and footwear.

Footwear

ANSI/ESD STM9.1-2006 Footwear – Resistive Characterization
This standard test method defines a way of measuring the electrical resistance of shoes used for ESD control in the electronics environment (not to include heel straps and toe grounders).

ESD SP9.2-2003 Footwear – Foot Grounders Resistive Characterization
This standard practice was developed to provide test methods for evaluating foot grounders and foot grounder systems used to electrically bond or ground personnel as part of an ESD Control Program. Static Control Shoes are tested using ANSI/ESD STM9.1.

Garments

ANSI/ESD STM2.1-1997 Garments - Resistive Characterization
Provides test methods for measuring the electrical resistance of garments. It covers procedures for measuring sleeve-to-sleeve resistance and point-to-point resistance.

ESD TR2.0-01-00 Consideration for Developing ESD Garment Specifications
This technical report addresses concerns about effective ESD garments by starting with an understanding of electrostatic measurements and how they relate to ESD protection.

ESD TR2.0-02-00 Static Electricity Hazards of Triboelectrically Charged Garments
This technical report is intended to provide some insight to the electrostatic hazards present when a garment is worn in a flammable or explosive environment.

Glossary

ESD ADV1.0-2009 Glossary of Terms
Definitions and explanations of various terms used in Association Standards and documents are covered in this advisory. It also includes other terms commonly used in the electronics industry.

Gloves and Finger Cots

ANSI/ESD SP15.1-2011 In-Use Resistance Testing of Gloves and Finger Cots
This standard practice provides test procedures for measuring the intrinsic electrical resistance of gloves and finger cots.

ESD TR15.0-01-99 ESD Glove and Finger Cots
This technical report reviews the existing known industry test methods for the qualification of ESD protective gloves and finger cots.

Grounding

ANSI/ESD S6.1-2009 Grounding
Specifies the parameters, materials, equipment and test procedures necessary to choose, establish, vary and maintain an electrostatic discharge control grounding system for use within an ESD Protected Area for protection of ESD susceptible items, and specifies the criteria for establishing ESD bonding.

Handlers

ANSI/ESD SP10.1-2007 Automated Handling Equipment (AHE)
This standard practice provides procedures for evaluating the electrostatic environment associated with automated handling equipment.

ESD TR10.0-01-02 Measurement and ESD Control Issues for Automated Equipment Handling of ESD Sensitive Devices below 100 Volts
This document provides guidance and considerations that an equipment manufacturer should use when designing automated handling equipment for these low voltage sensitive devices.

Hand Tools

ESD STM13.1-2000 Electrical Soldering/ Desoldering Hand Tools
This standard test method provides electric soldering/desoldering hand tool test methods for measuring the electrical leakage and tip to ground reference point resistance, and provides parameters for EOS safe soldering operation.

ESD TR13.0-01-99 EOS Safe Soldering Iron Requirements
This technical report discusses soldering iron requirements that must be based on the sensitivity of the most susceptible devices that are to be soldered.

Human Body Model (HBM)

ESDA/JEDEC JDS-001-2011 ESDA/ JEDEC Joint Draft Standard for Electrostatic Discharge Sensitivity Testing – Human Body Model (HBM) – Component Level
Establishes the procedure for testing, evaluating and classifying the electrostatic discharge sensitivity of components to the defined human body model (HBM).

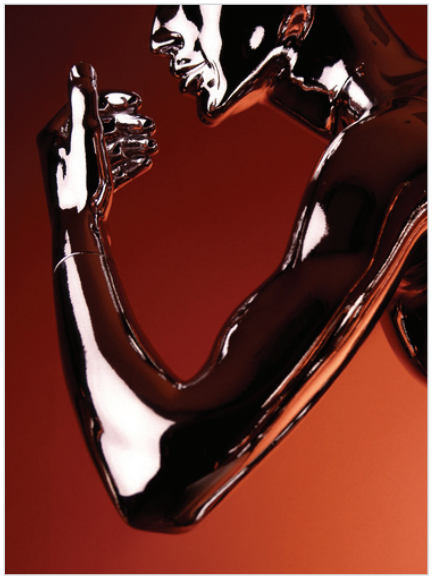
Human Body Model (HBM) and Machine Model (MM)

ANSI/ESD SP5.1.1-2006 Human Body Model (HBM) and Machine Model (MM) Alternative Test Method: Supply Pin Ganging – Component Level
This standard practice defines an alternative test method to perform Human Body Model or Machine Model component level ESD tests when the component or device pin count exceeds the number of ESD simulator tester channels.

ANSI/ESD SP5.1.2-2006 Human Body Model (HBM) and Machine Model (MM) Alternative Test Method: Split Signal Pin - Component Level
This standard practice defines another alternative test method to perform Human Body Model or Machine Model component level ESD tests when the component or device pin count exceeds the number of ESD simulator tester channels.

Human Metal Model (HMM)

ANSI/ESD SP5.6-2009 Electrostatic Discharge Sensitivity Testing - Human Metal Model (HMM) - Component Level
Establishes the procedure for testing, evaluating and classifying the ESD sensitivity of components to the defined HMM.



ESD TR5.6-01-09 Human Metal Model (HMM)
This technical report addresses the need for a standard method of applying the IEC contact discharge waveform to devices and components.

Ionization

ANSI/ESD STM3.1-2006 Ionization
Test methods and procedures for evaluating and selecting air ionization equipment and systems are covered in this standard test method. The document establishes measurement techniques to determine ion balance and charge neutralization time for ionizers.

ANSI/ESD SP3.3-2006 Periodic Verification of Air Ionizers
This standard practice provides test methods and procedures for periodic verification of the performance of air ionization equipment and systems (ionizers).

ESD TR3.0-01-02 Alternate Techniques for Measuring Ionizer Offset Voltage and Discharge Time
This technical report investigates measurement techniques to determine ion balance and charge neutralization time for ionizers.

ESD TR3.0-02-05 Selection and Acceptance of Air Ionizers
This document reviews and provides a guideline for creating a performance specification for the four ionizer types contained in ANSI/ESD STM3.1: room (systems), laminar flow hood, worksurface (e.g. blowers) and compressed gas (nozzles & guns).

Machine Model (MM)

ANSI/ESD S5.2-2009 Electrostatic Discharge Sensitivity Testing - Machine Model (MM) - Component Level
Establishes the procedure for testing, evaluating and classifying the ESD sensitivity of components to the defined MM.

ESD TR5.2-01-01 Machine Model (MM) Electrostatic Discharge (ESD) Investigation - Reduction in Pulse Number and Delay Time
This report provides the procedures, results and conclusions of evaluating a proposed change from 3 pulses (present requirement) to 1 pulse while using a delay time of both 1 second (present requirement) and 0.5 second.

Ohmmeters

ESD TR50.0-02-99 High Resistance Ohmmeters--Voltage Measurements
This technical report discusses a number of parameters that can cause different readings from high resistance meters when improper instrumentation and techniques are used, as well as the

techniques and precautions to be used in order to ensure the measurement will be as accurate and repeatable as possible for high resistance measurement of materials.

Packaging

ANSI/ESD STM11.11-2006 Surface Resistance Measurement of Static Dissipative Planar Materials
This standard test method defines a direct current test method for measuring electrical resistance, replacing ASTM D257-78. This test method is designed specifically for static dissipative planar materials used in packaging of ESD sensitive devices and components.

ANSI/ESD STM11.12-2007 Volume Resistance Measurement of Static Dissipative Planar Materials
This standard test method provides test methods for measuring the volume resistance of static dissipative planar materials used in the packaging of ESD sensitive devices and components.

ANSI/ESD STM11.13-2004 Two-Point Resistance Measurement
This standard test method measures the resistance between two points on a material's surface without consideration of the material's means of achieving conductivity. This test method was established for measuring resistance where the concentric ring electrodes of ANSI/ESD STM11.11 cannot be used.

ANSI/ESD STM11.31-2006 Bags
This document provides a method for testing and determining the shielding capabilities of electrostatic shielding bags.

ANSI/ESD S541-2008 Packaging Materials for ESD Sensitive Items
This standard describes the packaging material properties needed to protect ESD sensitive electronic items, and references the testing methods for evaluating packaging and packaging materials for those properties. Where possible, performance limits are provided. Guidance for selecting the types of packaging with protective properties appropriate for specific applications is provided, as well as other considerations for protective packaging.

ESD ADV11.2-1995 Triboelectric Charge Accumulation Testing
Provides guidance in understanding the triboelectric phenomenon and relates current information and experience regarding tribocharge testing as used in static control for electronics.

Seating

ANSI/ESD STM12.1-2006 Seating – Resistive Measurement
This document provides test methods for measuring the electrical resistance of seating used for the control of electrostatic charge or discharge. It contains test methods for the qualification of seating prior to installation or application, as well as test methods for evaluating and monitoring seating after installation or application.

Socketed Device Model (SDM)

ANSI/ESD SP5.3.2-2008 Electrostatic Discharge Sensitivity Testing – Socketed Device (SDM) – Component Level
This standard practice provides a test method for generating a Socketed Device Model (SDM) test on a component integrated circuit (IC) device.

ESD TR5.3.2-01-00 Socket Device Model (SDM) Tester
This technical report helps the user understand how existing SDM testers function, offers help with the interpretation of ESD data generated by SDM test systems, and defines the important properties of an "ideal" socketed-CDM test system.

Static Electricity

ESD TR50.0-01-99 Can Static Electricity Be Measured?
This report gives an overview of fundamental electrostatic concepts, electrostatic effects and, most importantly, electrostatic metrology, with special attention to what can and what cannot be measured.

Susceptible Device Concepts

ESD TR50.0-03-03 Voltage and Energy Susceptible Device Concepts, Including Latency Considerations
This technical report contains information to promote an understanding of the differences between energy and voltage susceptible types of devices and their sensitivity levels.

Symbols

ANSI/ESD S8.1-2007 Symbols – ESD Awareness
Three types of ESD awareness symbols are established by this document. The first one is used on a device or assembly to indicate susceptible to electrostatic charge. The second is to be used on items and materials intended for electrostatic protection. The third symbol indicates the common point ground.

System Level ESD

ANSI/ESD SP14.1-2004 System Level Electrostatic Discharge (ESD) Simulator Verification
This standard practice was developed to provide guidance to designers, manufacturers and calibration facilities for verification and specification of the systems and fixtures used to measure simulator discharge currents.

ESD TR14.0-01-00 Calculation of Uncertainty Associated with Measurement of Electrostatic Discharge (ESD) Current
This technical report provides guidance on measuring uncertainty based on an uncertainty budget.

Transient Latch-up

ANSI/ESD SP5.4-2008 Latch-up Sensitivity Testing of CMOS/Bi CMOS Integrated Circuits – Transient Latch-up Testing – Component Level Supply Transient Stimulation
This standard practice was developed to instruct the reader on the methods and materials needed to perform Transient Latch-Up Testing.

ESD TR5.4-01-00 Transient Induced Latch-Up (TLU)
This report provides a brief background on early latch-up work, reviews the issues surrounding power supply response requirements, and discusses efforts in RLC TLU testing, transmission line pulse (TLP) stressing and the new bi-polar stress TLU methodology.

ESD TR5.4-02-08 Determination of CMOS Latch-up Susceptibility - Transient Latch-up - Technical Report No. 2
This technical report is intended to provide background information pertaining to the development of the transient latch-up standard practice originally published in 2004 and additional data presented to the group since publication.

Transmission Line Pulse

ANSI/ESD STM5.5.1-2008 Electrostatic Discharge Sensitivity Testing – Transmission Line Pulse (TLP) – Component Level
This document pertains to Transmission Line Pulse (TLP) testing techniques of semiconductor components. The purpose of this document is to establish a methodology for both testing and reporting information associated with TLP testing.

ANSI/ESD SP5.5.2-2007, Electrostatic Discharge Sensitivity Testing - Very Fast Transmission Line Pulse (VF-TLP) - Component Level
This document pertains to Very Fast Transmission Line Pulse (VF-TLP) testing techniques of semiconductor components. It establishes guidelines and standard practices presently used by development, research and reliability engineers in both universities and industry for VF-TLP testing. This document explains a methodology for both testing and reporting information associated with VF-TLP testing.

ESD TR5.5-01-08 Transmission Line Pulse (TLP)
This technical report is a compilation of the information gathered during the writing of ANSI/ESD SP5.5.1 and the information gathered in support of moving the standard practice toward re-designation as a standard test method.

ESD TR5.5-02-08 Transmission Line Pulse Round Robin
This report is intended to provide data on the repeatability and reproducibility limits of the methods of ANSI/ESD STM5.5.1.

Workstations

ESD ADV53.1-1995 ESD Protective Workstations
This Advisory document defines the minimum requirements for a basic ESD protective workstation used in ESD sensitive areas. A test method is provided for evaluating and monitoring workstations. It defines workstations as having the following components: support structure, static dissipative worksurface, any attached shelving or drawers, and means of grounding personnel.

Worksurfaces

ANSI/ESD S4.1-2006 Worksurface - Resistance Measurements
Provides test methods for evaluating and selecting worksurface materials, testing of new worksurface installations, and the testing of previously installed worksurfaces.

ANSI/ESD STM4.2-2006 ESD Protective Worksurfaces - Charge Dissipation Characteristics
Aids in determining the ability of ESD protective worksurfaces to dissipate charge from a conductive test object placed on them.

ESD TR4.0-01-02 Survey of Worksurfaces and Grounding Mechanisms
This document provides guidance for understanding the attributes of worksurface materials and their grounding mechanisms.

Wrist Straps

ANSI/ESD S1.1-2006 Wrist Straps
A successor to EOS/ESD S1.0, this document establishes test methods for evaluating the electrical and mechanical characteristics of wrist straps. It includes improved test methods and performance limits for evaluation, acceptance and functional testing of wrist straps.

ESD TR1.0-01-01 Survey of Constant (Continuous) Monitors for Wrist Straps
This technical report provides guidance to ensure that wrist straps are functional and are connected to people and ground. IN

(the author)

THE ESD ASSOCIATION
Founded in 1982, the ESDA is a professional voluntary association dedicated to advancing the theory and practice of electrostatic discharge (ESD) avoidance. From fewer than 100 members, the Association has grown to more than 2,000 throughout the world. From an initial emphasis on the effects of ESD on electronic components, the Association has broadened its horizons to include areas such as textiles, plastics, web processing, cleanrooms and graphic arts. To meet the needs of a continually changing environment, the Association is chartered to expand ESD awareness through standards development, educational programs, local chapters, publications, tutorials, certification and symposia.

BUSINESS News

Joint Marketing Agreement Announced for Antenna Pattern Measurement System

Panashield, an installer of shielded rooms and anechoic chambers around the world, recently announced its agreement with Diamond Engineering to jointly promote antenna pattern measurement systems. Diamond Engineering has a broad range of APM systems that Panashield will cross sell with its line of anechoic chambers. Through this joint agreement, the companies will also be able to offer their combined line as turn-key solutions. These products are available through Panashield independent representatives and were featured at the recent AMTA Conference in Denver.

Sealed Mini-USB Connectors for Machine Tool, Automation, Automotive and Other Extreme Environment Applications

A Mini-USB connector compliant with USB 2.0 specifications has been introduced by CONEC to expand its bayonet-locking and water-resistant series of connectors. The new Mini-USB connector provides a reliable option for the harshest environments, It is the latest addition to the expansive IP67-rated family widely used in industrial production, food/beverage, chemical controllers process, outdoor wireless, Bluetooth adapters, diagnostic and test instruments, oil/gas and factory

automation applications. For more information, visit www.conec.com, email info@conec.com, or call 919-460-8800.

Teseq Offers New ESD Simulator with Built-in Discharge Relay

A new ESD simulator that is safe and easy to operate hopes to set standards in flexibility and reproducibility. Teseq Inc., a leading developer and provider of instrumentation and systems for EMC emission and immunity testing, introduces its NSG 438A. By connecting a 1 M ohm resistor from the EUT to ground for a controlled time segment that dissipates the residual voltage, the NSG 438A has set new benchmarks in flexibility and reproducibility of EMC testing. The design includes an integrated discharge relay circuit to dissipate residual voltage in conventional ESD testing and ungrounded EUT applications. For more information, visit www.teseq.com or call 732-417-0501.

New Quick Reference EMI Shielding Guide Available from Leader Tech

To help engineers who are trouble shooting diverse and often elusive EMI issues, Leader Tech has published a 6-page, quick reference guide that includes an overview of company products and capabilities. From FerriShield cable ferrites to advanced Fabric Shielding Gaskets and military-grade Circuit Boad Shields, engineeres can quicky find cost-effective solutions to their problem. This allows engineers to reduce time-to-market, lower shielding expense and benefit from single-source responsibility. Leader Tech's Products and Capabilities Overview brochure is available for immediate download from the company's website at www.leadertechinc.com or by calling (813) 855-6921.

New Waveform Generator Focuses on Fast Sample Rates and High Resolution Display

The new DG4000 Series function/arbitrary waveform generator has been introduced by Rigol Technologies, Inc.

to target the requirements of R&D engineers, production test engineers, teaching labs and advanced researchers. The latest development in their family of fast, easy-to-use test instruments, the DG4000 helps engineers accomplish a range of testing by combining multiple functions into one instrument. Functions include arbitrary waveform generator, function generator, pulse generator, harmonic generator and analog/digital modulator. The DG4000 series also incorporates Rigol's Direct Digital Synthesizer (DDS) technology, designed to ensure signals are delivered with stability, precision, purity and low distortion. For more information visit www.Rigolna.com.

Wurth Electronics Midcom Introduces T8 Transformers for LED Tube Lighting

A global leader in the design and manufacture of custom transformers introduces the T8 transformer series, specifically designed for T8 sized tube LED applications. These transformers, built using two new packages developed by Wurth Electronics Midcom, are the only transformer packages in the industry designed specifically for the T8 bulb form factor. The patent-pending designs feature innovative, half-rounded cores to maximize core cross-sectional area. Up to 30W power is available on the through-hole design and 20W on the surface-mount packages. Both package styles provide high efficiency and low leakage inductance. The shielded construction and rounded cores provide reliable EMI performance, with an operating temperature ranging from -40°C to 125°C. Applications include the T8 tube lighting, in flyback topology, with functional, basic, supplementary or reinforced isolation. For more information, visit our website at www.weonline.com/midcom.

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We wish to thank our community of knowledgeable authors, indeed, experts in their field - who come together to bring you each issue of *In Compliance*. Their contributions of informative articles continue to move technology forward.

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began his career in electromagnetics at Plessey Research Labs, designing "Stealth" materials for the British armed services. In 1973 he moved to the USA and established a new manufacturing plant for Plessey. For Brian's full bio, please see page 16.

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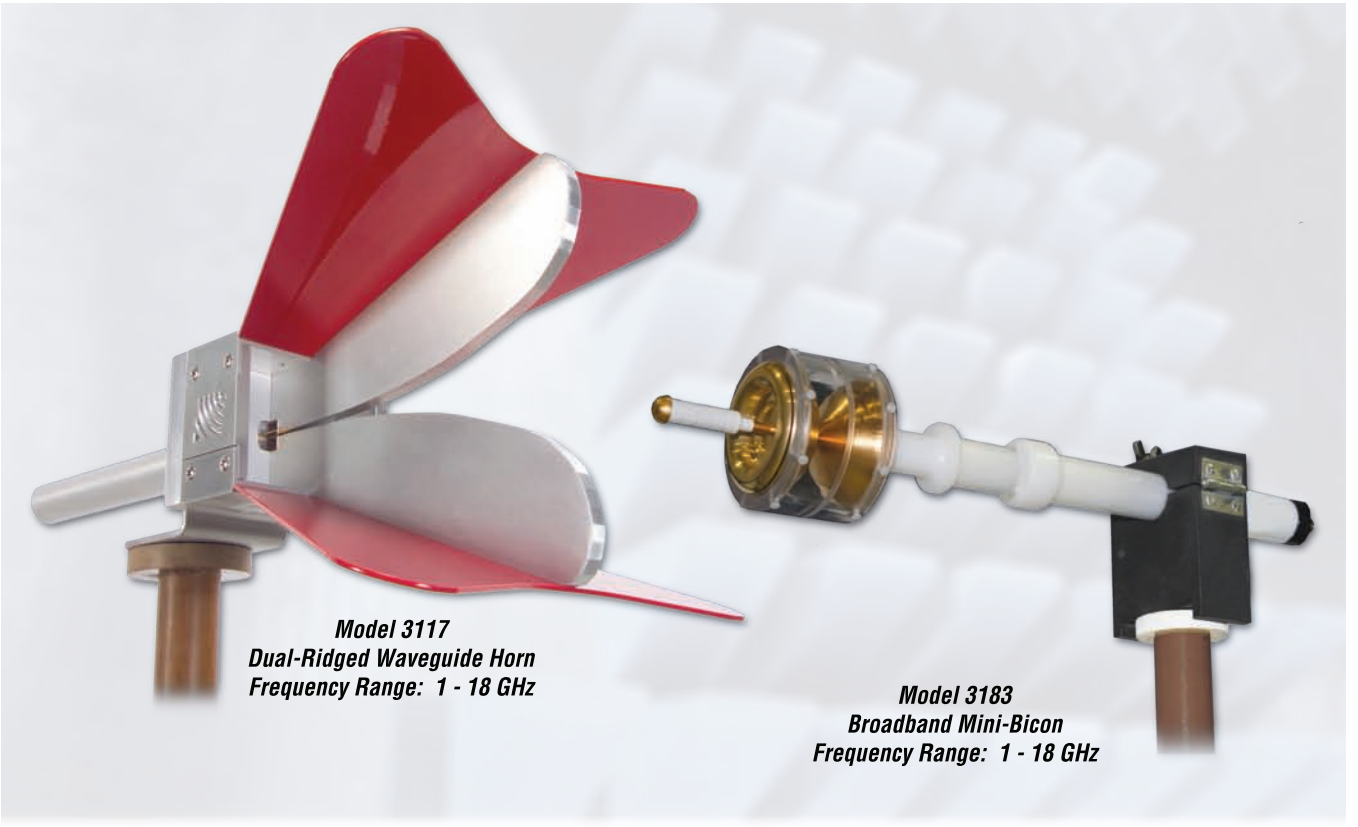

CISPR 16-1-4 Chamber Characterization:

The Antennas You Need Are Here!

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The new CISPR 16-1-4 standard requires chambers to be characterized above 1 GHz. ETS-Lindgren has a pair of broadband antennas that make the task easier. Both antennas have an operating frequency range of 1-18 GHz, so you don't have to stop for band breaks.

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Information for the antennas featured here is available at www.ets-lindgren.com/3117 and www.ets-lindgren.com/3183.

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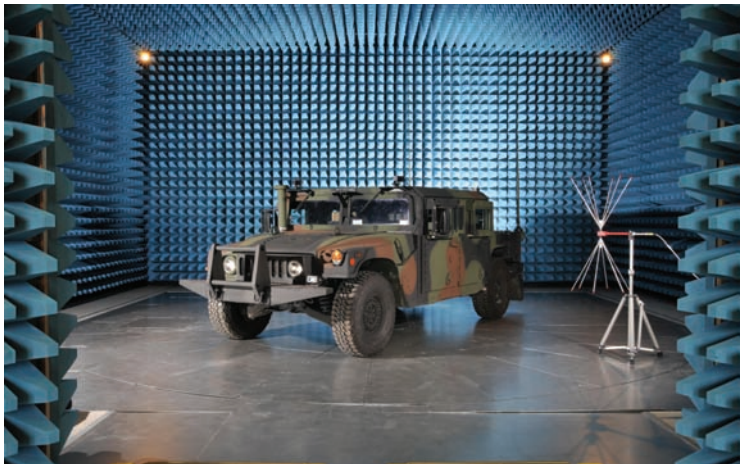

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