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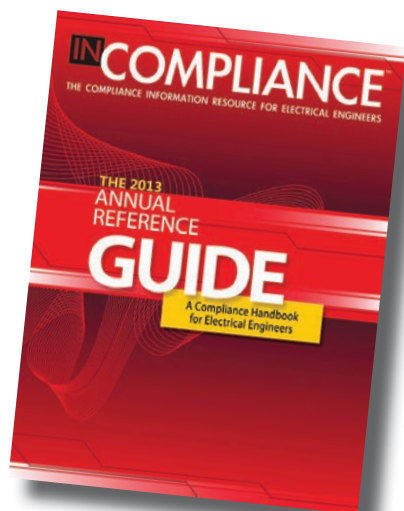
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tel: (978) 486-4684

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editorial staff

editor/publisher Lorie Nichols

lorie.nichols@incompliancemag.com

(978) 873-7777

production director Erin Feeney

erin.feeney@incompliancemag.com

(978) 873-7756

publishing staff

director of sales Sharon Smith

sharon.smith@incompliancemag.com

(978) 873-7722

national sales manager Shellie Johnson

shellie.johnson@incompliancemag.com

(404) 991-8695

marketing communications specialist Heather Stehman

heather.stehman@incompliancemag.com

(978) 873-7710

marketing communications strategist Ashleigh O'Connor

ashleigh.oconnor@incompliancemag.com

(978) 873-7788

circulation manager Alexis Harrington

alexis.harrington@incompliancemag.com

(978) 873-7745

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advertising

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sharon.smith@incompliancemag.com

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24 Wireless Certification in the Land of the Rising Sun

The first broadcasting station in Japan went on-air in 1925, a scant five years after the first radio station went live in the United States. A year later, Nippon Hōsō Kyōkai (NHK) was chartered by the Japanese government and is still the official public broadcast entity.

Mike Violette

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FEATURES

30 A 1kV Discharge Directly onto a Staple Leads to Increased Energy Penetration Inside Metallized Static Shielding Bags

Due to the overwhelming amount of positive feedback from the September 2013 issue of In Compliance (pp. 42-48), a follow-up article with additional lab testing by the author was necessary to respond to an aerospace prime.

Bob Vermillion

38 Electromagnetic Interference Shielding Effects in Wireless Power Transfer Using Magnetic Resonance Coupling for Board-to-Board Level Interconnection

In this article, the authors present the analysis of electromagnetic interference (EMI) shielding effects of wireless power transfer (WPT) using magnetic resonance coupling for board-to-board level interconnection. Board-to-board WPT consists of source coil, receiver coil, and load which are manufactured on printed circuit board (PCB).

Sukjin Kim, Hongseok Kim,
Jonghoon J. Kim, Bumhee Bae,
Sunkyu Kong and Joungho Kim



FCC News

Wireless Carrier Settles FCC HAC Investigation

A wireless carrier will pay a six-figure "voluntary contribution" for failing to comply with regulations designed to ensure the availability of hearing aid-compatible (HAC) phones in the marketplace.

NTT DOCOMO USA has agreed to pay \$100,000 to end an investigation by the Enforcement Bureau of the Federal Communications Commission (FCC) into the company's provision of HAC phones to consumers. FCC

compliance with FCC HAC regulations, including new operating procedures, comprehensive training of employees and agents, and additional reporting requirements.

According to the FCC, the settlement with NTT DOCOMO USA is the latest in a series of HAC-related enforcement actions against wireless carriers in 2013, which has reportedly generated more than \$1.4 million.

The complete text of the Consent Decree with NTT DOCOMO USA is available at incompliancemag.com/news/1311_01.

VRs and mobile repeaters are instrumental in providing fire fighters and other first responders with enhanced radio coverage within buildings and at other emergency sites. This is especially important since modern construction materials can attenuate radio signals, potentially jeopardizing the safety of first responders or hampering their efforts.

In response to a petition filed by Pyramid Communications, the FCC has proposed allowing the operation of VRS on six remote control and telemetry channels at 173 MHz, subject to the detailing of procedures to coordinate

The FCC may be expanding the existing spectrum allocation for vehicular repeater systems (VRSs) and other types of mobile repeaters.

regulations specify technical standards that digital wireless phones must meet to ensure compatibility with hearing aids, and establish deadlines by which carriers must offer specified numbers or percentages of HAC phones to consumers.

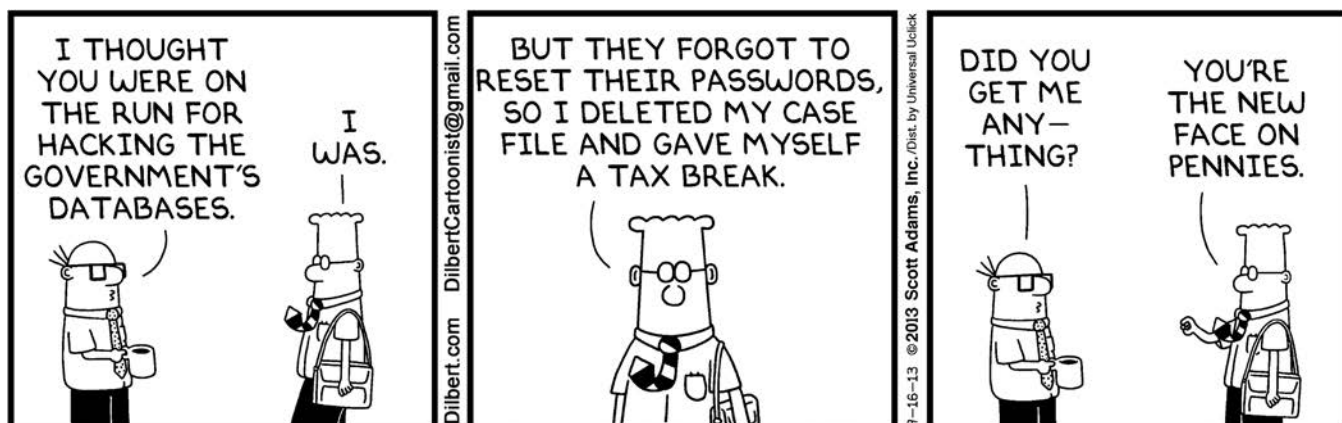
As part of the settlement agreement, NTT DOCOMO USA has also agreed to implement a formal plan to achieve

FCC Proposes Expanded Spectrum for Mobile Repeater Units

The U.S. Federal Communications Commission (FCC) is evaluating whether to expand existing spectrum allocation for vehicular repeater systems (VRSs) and other types of mobile repeaters.

spectrum use without interference. Comments on the Commission's proposed rules are due by mid-November 2013.

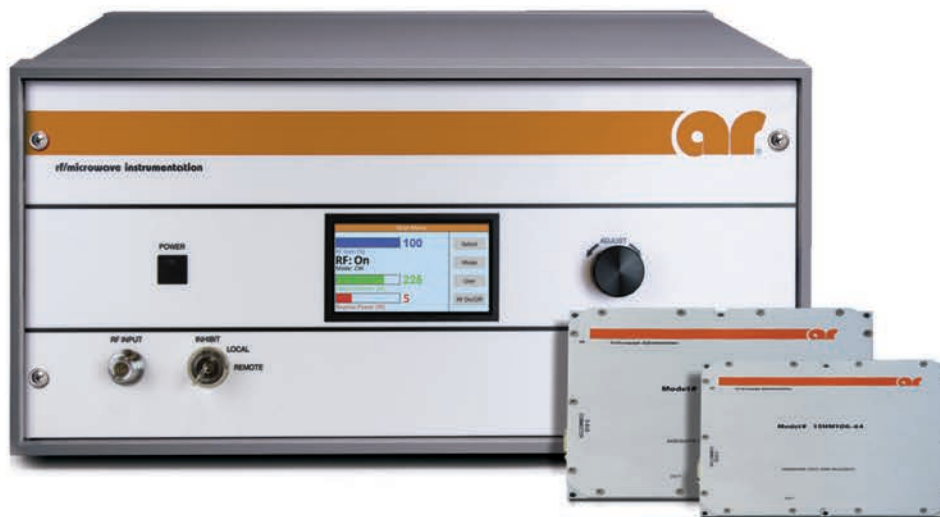
The complete text of the Commission's Order and Notice of Proposed Rulemaking is available at incompliancemag.com/news/1311_02.



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European Union News

EU Commission Updates Standards List for ATEX 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 its directive concerning equipment and protective systems intended for use in potentially explosive atmospheres.

The directive, 94/9/EC, which is also known as the ATEX Directive, applies to “machines, apparatus, fixed or mobile devices, control components and instrumentation...and detection or prevention systems which...are intended

Updated Standards List Published for the EU's Electrical Safety 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 its directive relating to electrical equipment designed for use within certain voltage limits (2006/95/EC).

The Directive defines ‘electrical equipment’ as any device designed for use with a voltage rating of between 50 and 1000 V for alternating current, and between 75 and 1500 V for direct current.

Updated List of Standards Released for EU's Directive on General Product Safety

The Commission of the European Union (EU) has published an updated list of standards that can be used to demonstrate compliance with the essential requirements of its Directive 2001/95/EC, related to general product safety.

The EU's General Product Safety Directive covers “any product...which is intended for consumers or likely, under reasonably foreseeable conditions, to be used by consumers even if not intended for them, and is supplied or made available, whether for consideration

The EU Commission has updated the standards lists for the ATEX Directive (94/9/EC), the Electrical Safety Directive (2006/95/EC), and the General Product Safety Directive (2001/95/EC). These lists of standards can be used to demonstrate conformity with the essential requirements of each directive.

for the generation, transfer, storage, measurement, control and conversion of energy and/or the processing of material,” and “which are capable of causing an explosion through their own potential sources of ignition.”

The updated list of standards was published in September 2013 in the *Official Journal of the European Union*, and replaces all previously published standards lists for the ATEX Directive.

The complete list of standards can be viewed at incompliancemag.com/news/1311_03

The updated list of standards that can be used to demonstrate compliance with the Directive was published in September 2013 in the *Official Journal of the European Union*, and replaces all previously published standards lists.

The complete list of standards can be viewed at incompliancemag.com/news/1311_04 (note that the list runs over 100 pages!).

or not, in the course of a commercial activity, and whether new, used or reconditioned.” The Directive is intended to ensure the general safety of products beyond those specific safety issues addressed in other product directives, such as the Machinery Directive, the EMC Directive, or the R&TTE Directive.

The list of CEN standards was published in September 2013 in the *Official Journal of the European Union*, and replaces all previously published standards lists for the Directive.

The revised list of standards is available at incompliancemag.com/news/1311_05.

FDA News

FDA to Require IDs for High-Risk Medical Devices

The U.S. Food and Drug Administration (FDA) has issued regulations that will require most medical devices distributed in the U.S. to display a unique identifying number that will aid in the identification and recall of potentially hazardous devices.

The Final Rule, which was published in the U.S. *Federal Register* in September 2013, will mandate the use of unique device identifiers (UDIs) by medical device manufacturers. Each UDI will consist of a device identifier that indicates a specific model or version of

a device, and a production identifier, which provides a device-specific identification code as well as production information and device expiration date.

Under the new regulations, the FDA will also create a Global Unique Device Identification Database (GUDID) that will allow manufacturers to post UDI information for public access so that consumers can search for up-to-date information on the safety status of a given medical device. The FDA has published a GUDID draft guidance document to aid manufacturers in submitting product information for posting.

The UDI requirements will come into effect over the next seven years, with initial regulations applicable to Class III medical devices effective as of September 24, 2014. The FDA says that the new UDI requirements will allow more timely and accurate reporting and analysis of adverse events associated with specific medical devices, so that unsafe devices can be identified more quickly.

The complete text of the FDA's Final Rule on UDIs is available at incompliancemag.com/news/1311_06. The FDA's GUDID draft guidance document is available at incompliancemag.com/news/1311_07.

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CPSC News

Dehumidifiers Recalled Due to Fire and Burn Hazards

Gree Electrical Appliances of China has announced the recall of about 2.2 million dehumidifiers sold under various brand names in the U.S. and Canada.

The company says that the dehumidifiers can overheat, smoke and catch fire, posing fire and burn hazards to consumers. Gree says that it has received reports of 165 separate incidents related to the recalled dehumidifier units, including 46 fires and \$2.15 million in property damage. However, there have been no reports of injuries.

The recalled dehumidifiers were sold through major home improvement stores in the U.S. and Canada, and through Amazon.com and eBay.com from January 2005 through August 2013 for between \$110 and \$400, depending on the unit's capacity. The dehumidifiers were sold under a number of different brand names, including Danby, DeLonghi, Fedders, Frigidaire, Kenmore and SoleusAir.

A complete list of the specific dehumidifier makes and models

affected by this recall is available at incompliancemag.com/news/1311_08.

Personal Emergency Response Systems Recalled

Visonic Ltd. of Westford, MA has issued a product recall for about 24,000 of its personal emergency response system kits manufactured in Israel.

Visonic reports that, when the system's base station is set to "common area" mode, it can fail to detect a low battery or dead battery warning signal from a remote pendant. This failure can result in a consumer's inability to signal for assistance in an emergency. The company says that it has received one report of a pendant failing to operate due to an undetected low battery condition, but no reports of consumer injuries.

The recalled personal emergency response systems were sold by Visonic distributors and professional alarm installation firms nationwide from January 2008 through August 2013 for between \$220 and \$240.

Further details about this recall are available at incompliancemag.com/news/1311_09.

Target Recalls Floor Lamps

The Target Corporation of Minneapolis, MN has announced the recall of approximately 25,000 two-bulb floor lamps manufactured in China.

According to the company, the floor lamp can short when a standard one-way bulb is fully tightened in the lamp's three-way socket, creating the potential for a short circuit and posing a shock and fire hazard to consumers. Target says that it has six reports of lamps short circuiting, resulting in fires and minor property damage, and two consumers who experienced electric shock.

The recalled lamps were sold at Target stores nationwide and through Target.com from September 2012 through May 2013 for about \$70.

Additional details about this recall are available at incompliancemag.com/news/1311_10.

You Can't Make This Stuff Up

"First Laugh, Then Think"

Much of the world's attention this month is focused on the 2013 crop of Nobel Prize winners. But an equally compelling, if somewhat eccentric, annual awards ceremony may do as much to foster interest in science, technology and medicine as its more noble (!) counterpart.

The 23rd 1st Annual (not a typo!) Ig Nobel Prize ceremony was held in September 2013 at Harvard University's Sanders Theatre. According to the folks

at Improbable Research (the group behind the Ig Nobel Prize), the Prizes are intended to "honor achievements that first make people laugh and then make them think."

This year's Ig Nobel Prize award winners this year included:

- For medicine, Japanese researchers who investigated the effect of opera music on mice who have undergone heart transplantation;
- For psychology, researchers who confirmed that people who think

they are drunk also think they are attractive;

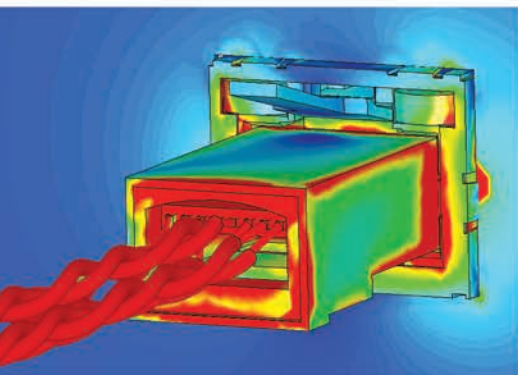
- Jointly for biology and astronomy, researchers who discovered that dung beetles can navigate by looking at the Milky Way;
- And, for safety engineering, the late Gustano Pizzo, for inventing an electro-mechanical system to trap airplane hijackers.

Details of additional winners are available at the Improbable Research website at incompliancemag.com/news/1311_11.



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How Is Static Electricity Generated?

Predicting the level of static build-up is rarely possible.

BY NIELS JONASSEN

Nearly all static-electric phenomena are caused by the interaction between charges located on the surfaces of bodies which might be conductive as well as insulative. A basic question, therefore, is, how do the bodies obtain the charges? We will present a qualitative overview of the physical processes involved in static build up.

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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The title might seem to imply a discussion on developing formulas for quantitatively predicting the magnitude of electrification from material parameters and other physical conditions. Quantitative predictions, however, are rarely possible.

It is important to first stress that charges are never generated. They always exist in atoms—as positive charges on the protons of the nuclei, and as negative charges on the electrons around the nuclei. An electric effect can be seen only when electrons are removed from some of the atoms in one material and transferred to atoms in another (or maybe even the same) material. The electric effect is caused by the attraction between opposite charges and the repulsion between like charges.

We are normally only aware of this effect if the electron-exchanging materials are separated in such a manner that at least part of the charges do not reunite during the separation

process. The transfer of electrons between atoms or molecules might occur when two solids—identical or different—contact each other, with electrons crossing the interface in a preferential direction, giving one material a positive and the other a negative excess charge.

The exchange of electrons could also occur when an insulative liquid flows through a tube, when a liquid of almost any type breaks up into droplets of nonuniform magnitude, or when droplets fall through an inhomogeneous field, such as in a thundercloud.

The number of electrons transferred in any charging process is enormous. Here are some examples. If a powder, such as sugar or flour, slides down a tube and sticks to the wall, the charge on each tiny particle could be 10^{-14} to 10^{-13} C, i.e., 100,000 to 1 million electrons have been transferred per particle. A person who has walked across a carpeted floor receives a shock when touching

a doorknob that typically has a charge of about 10^{-7} C. Powder sliding down a tube often has a specific charge of about 10^{-7} C • kg⁻¹. A plastic folder rubbed with a piece of cloth or fur typically produces a charge of 10^{-7} C per sheet.

CHARGING OF SOLIDS: TRIBOELECTRIFICATION

The most important type of charge separation involves the contact and friction between solids known as triboelectrification. When two solid materials, A and B (see Figure 1), contact and possibly rub against each other, electrons could move across the interface.

Metals. It may be surprising that triboelectrification also happens when the two contacting materials are metals. And even more surprising is that this friction between metals is the only case in which the result of the charge transfer can be accurately predicted. When two metals contact, a voltage difference is established across

the interface—the so-called contact potential difference—with a magnitude from a couple of tenths to a few volts.

If the metals are “well-defined” metals, the contact potential difference can be calculated from the work functions, i.e., the energy it takes to remove a loosely bound electron from the metal. It should be stressed, however, that this charge exchange between metals only gives rise to what we normally understand as static electricity when the two metals are separated extremely quickly, such as when a metal powder is blown against a metal surface.

Insulators. It is likely that processes similar to those described for metals could take place during contact between materials of which one or both are insulators. It is, however, difficult to

characterize completely an insulating surface. For many materials, especially noncrystalline ones, the energy levels are badly defined and, therefore, the detailed contact processes are not known.

It is conceivable that only electrons located close to the surface can participate in the charging of highly insulative materials. Similar to metals, for some of these materials it is possible to measure the work function for loosely bound electrons. Because the measured values only hold true for materials with well-defined surface states, the practical implication of this is small.

As soon as a surface prepared in vacuum is exposed to ordinary air, the state—including the energy levels

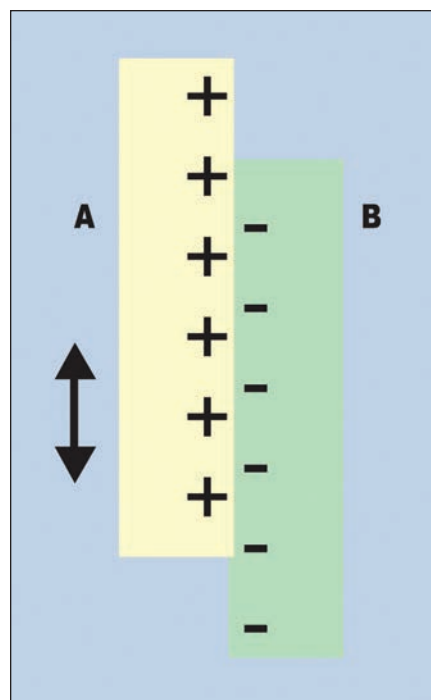


Figure 1: Triboelectrification



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One of the material parameters influencing the course of a charging process between two solid materials is the permittivity. Permittivity is defined as the ratio between corresponding values of the dielectric displacement and the electric field strength.

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Plexiglass
Bakelite
Cellulose nitrate
Glass
Quartz
Nylon
Wool
Silk
Cotton
Paper
Amber
Resins (natural and man-made)
Metals
Rubber
Acetate rayon
Dacron
Orlon
Polystyrene
Teflon
Cellulose nitrate
Polyvinyl chloride
Negative end

Table 1: An example of a triboelectric series

of surface electrons—can change considerably. Consequently, charging experiments with insulators can only yield quantitatively predictable results if the surfaces are carefully prepared and the experiments are performed in vacuum. And such experiments might disclose very little about what one could expect to find under more-practical conditions.

CONTACT ELECTRIFICATION: TRIBOELECTRIC SERIES

One of the material parameters influencing the course of a charging process between two solid materials is the permittivity. Scientifically speaking, permittivity is defined as the ratio between corresponding values of the dielectric displacement and the electric field strength. However, in this context, it is more important that permittivity is also a measure of the ability of the material to become polarized.¹ If an ion or another small, charged atomic or molecular cluster lands on an insulative surface, it will be bound to the surface by polarization forces. The stronger the forces, the higher the permittivity of the material.

This is the background for Coehn's law, which states that when two materials are in contact with each other, the one with the highest permittivity becomes positive. This law was originally based on a comparison of known values of permittivity and published triboelectric series (i.e., a list of materials arranged in such an order that any material will become positively charged when

rubbed against another material that is nearer the negative end of the series). There is no doubt that such a correlation exists, but with quite a few exemptions. And certain groups of materials can even be arranged in a closed series.

Table 1 shows an example of a triboelectric series. Such a series should be used with caution because the order of the materials could vary from series to series. Some series even locate air at the top of the positive end, which is a mistake.

From the relative position of a material in a series, it is possible to predict the sharing of polarity. However, the magnitude of the charges separated by contact and friction between two given materials can only be predicted with a high degree of uncertainty.

The magnitude of the charges often increases with the degree of friction between the surfaces, and the reason for this could be that the rubbing increases the area of contact between the surfaces while the charging process itself is only governed by the energy state of the surfaces, and that charged particles cross the interface at points of sufficient proximity. This, however, is hardly a satisfactory interpretation, because then it wouldn't be possible to explain the fact that two identical surfaces can get charged by rubbing against each other. It could be argued, though, that no two surfaces are ever identical, and that incidental and uncontrollable differences might cause different affinities to charged particles.

Other conditions, such as the existence of external electric fields across interfaces, may also play a role in charge exchange between contacting solid materials. This effect can be used in an electrostatic separation process.

ASYMMETRIC FRICTION

As mentioned earlier, the degree of friction between two materials influences the contact area, and thus the exchange of charges. But the process of friction could have a specific influence of its own. It can be demonstrated that if two identical surfaces—macroscopically speaking—are rubbed against each other in such a way that the contact takes place between a small area of one surface and a larger area of the other, the polarities of the surfaces are likely to change if the roles of the surfaces are interchanged. Figure 2 illustrates this process. Two pieces—A and B—of the same material are rubbed against each other. In Figure 2a, A is stationary and B is being used as the bow on a string. If the bow, B, becomes positive, then, when the roles of A and B are reversed, the bow (in this case A) will again be positive, as seen in Figure 2b. This is asymmetrical friction.

A possible explanation of this phenomenon is that the asymmetry

could cause a thermal gradient to develop between the surfaces, thereby inducing already existing charge carriers to move in a certain direction. It is also possible that the charge carriers are produced by a thermal dissociation of the material into charged components.

Other conditions, such as the existence of external electric fields across interfaces, may also play a role in charge exchange between contacting

solid materials. This effect can be used in an electrostatic separation process.

Postcontact Processes. Although contact between metals might produce charge transfer, no net charge will remain on the metals after separation unless at least one of the metals is insulated and the separation happens very quickly. If, on the other hand, at least one of the materials is an insulator, both surfaces will be charged immediately after separation. If they are

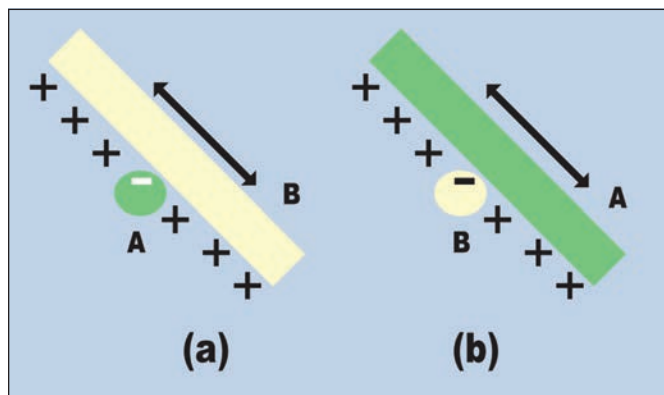


Figure 2: Asymmetrical friction.



If a liquid is flowing through a tube, there is a tendency for the outer charge of the double layer to be given off to the tube and the inner charge to be carried along with the flow.

both insulative or if one is an insulated conductor, the charges might remain on the materials even when they are far removed from each other.

During the initial separation, a series of processes could take place that would reduce the magnitude of the charges remaining on the surfaces. Such processes include decay and various types of discharges, ranging from corona discharge to regular sparks.

CHARGING OF LIQUIDS

The charging of solid materials by contact and friction is the best known type of static electrification, but it is not the only one. Liquids can also get charged, by flowing through tubes or by spraying, for example. However, the mechanism involved in the charging of liquids is somewhat different from the processes active in solids charging.

It has been demonstrated that phenomena like electrophoresis and capillary electricity in aqueous solutions can be explained if it is assumed that, on the interface between a liquid and a solid, or between a liquid and a gas, an electrical double layer exists in the liquid with a layer of charge close to the surface and a layer of the opposite polarity a short distance into the liquid.

Flow and Spraying. If the surface of a liquid is changed, the electric double layer has to be formed or destroyed. These processes are supposed to have a certain inertia, which implies that it is possible to separate the charges of the double layer by mechanical action on the liquid.

If a liquid is flowing through a tube, there is a tendency for the outer charge of the double layer to be given off to the tube and the inner charge to be carried

along with the flow (see Figure 3). The effect of the charging increases with the resistivity of the fluid (and depends on several other parameters). Consequently, only highly insulative liquids ($\rho > \text{ca. } 10^7 \Omega \cdot \text{m}$) will show charging by flow. Water, therefore, will not charge by flow.

It is well known that the breaking up of a liquid into droplets could cause charge separation. This is what happens with waterfall electricity or whenever water is broken into droplets (see Figure 4) where the fine mist, consisting mainly of very small droplets, is predominantly negative and the larger water drops, precipitating more easily, are positive.

Although charging of liquids by flow can only occur with highly insulative liquids, charging by spraying can happen with almost any liquid.

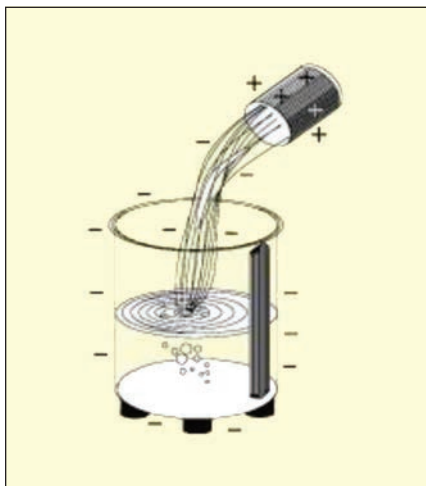


Figure 3: Electrification by flow of liquid

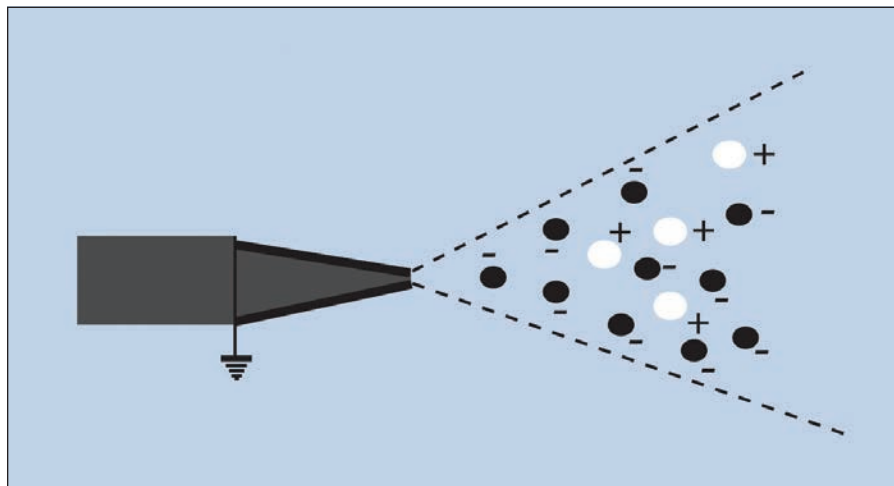


Figure 4: Electrification by spraying of liquid

It is very rarely possible to accurately predict the level of static buildup one might encounter under certain, even well-defined, working conditions, but there are exceptions.

CHARGING OF POWDERS

Dust and powders can get charged by contact or friction between the particles, especially if the individual particles have different properties, such as varying sizes or differing materials. Such charging could result in the particles sticking together. More common, however, are processes in which a powder is being transported through a system of tubes, and the powder as a whole is being charged by friction with the walls of the tube system. This kind of charging might take place if either the powder, the tubes, or both are insulative.

CHARGING OF GASES

This section could actually be abbreviated to a single phrase: Gases do not charge! But it is not uncommon to find large static charges where gases are used in connection with transport of liquids and solids such as powders. This phenomenon is often interpreted as a charging of the gas itself. This, however, is not the case.

The kinetic energy that might be imparted to a gas molecule in an airflow—even at high velocities—is much lower than the thermal kinetic energies at normal temperatures. It is also much lower than the level required to knock an electron off either the gas molecule itself or the container walls, for instance.

This theoretical prediction is backed by experiments in which filtered air is blown against a solid surface. No

charging occurs. The charging observed with ordinary compressed air is caused by liquid or solid impurities of the gas impinging on the target and, therefore, is a case of dust charging rather than gas charging. The polarity of the target charge can be either positive or negative, depending on the nature of the target as well as that of the impurities.


Placing air at the top of a triboelectric list, therefore, makes no sense. Nearly all charging experiments I have done with nonfiltered air impinging on a variety of solid materials have shown a positive charge on the target, which apparently should place air at the negative end of the list. But that, too, is wrong. All experiments with carefully filtered air show no charging, demonstrating that gases do not charge.

CONCLUSION

It is very rarely possible to accurately predict the level of static buildup one might encounter under certain, even well-defined, working conditions, but there are exceptions. If one is dealing with liquids flowing through tube systems and the resistivities, resistances, capacitances, flow rates, and system geometry are known, then it is certainly possible to calculate fairly accurately the charging currents and equilibrium voltages.

But if one is dealing with the conditions in the electronic industry, little is usually known about the charging conditions. Materials with often-unknown properties are rubbing

against each other and exchanging charges at an unknown and unpredictable rate. Sometimes one can measure the end result, but here one should be aware that the measurement itself could interfere essentially with the quantity to be measured.

So we're left with the question: What can we do? Can we do something to prevent charging? The short answer: very little. Can we do something to abate the effects of the charging? The answer: a lot. Abating the effects will be addressed in a future column. 

REFERENCE

1. Niels Jonassen, "Polarization, for Better or Worse," in *Mr. Static, Compliance Engineering* 17, no. 5 (2000): 34–40.

(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.



The View from the Chalkboard

BY MARK STEFFKA

In the last edition of this column (August, 2013) you may recall that I had an interview with Dr. Bogdan Adamczyk of Grand Valley State University (GVSU) about how he established an electrical engineering curriculum that includes the opportunity for students to become familiar and have lab experiences in EMC. One of the key aspects of that program is also the linkage to local industry.

For this edition, I have “flipped” that perspective around, and have interviewed an EMC Lab manager who has established a successful EMC group within his own company, by actively seeking out students that have taken EMC courses and have expressed an interest in EMC testing.

The lab is at the Hitachi Automotive Systems Americas, Inc., facility in Farmington Hills, Michigan. The lab manager is Mr. Barry Steltz, and three of the members of his group are Mr. Kevin McCarthy, Mr. Jon Rykalsky, and Mr. Paul Gojcay. It is hoped that Mr. Steltz’ experiences and insights into the value of formal EMC education and the needs of industry will provide guidance to others

Barry Steltz

Mark Steffka: Mr. Steltz, can you tell us a little about yourself?

Barry Steltz: I have a BSEE and MBA from the Pennsylvania State University. I am a NARTE certified EMC Engineer with 20+ years’ experience in Military, Commercial and Automotive, EMC design and testing.

Mark Steffka: How long have you been the EMC lab manager?

Barry Steltz: I have been at Hitachi for 9 years and prior to that, spent 4 years at Ballard power systems

Mark Steffka: Can you give us an overview of your background and how you came to Hitachi?



Barry Steltz: I worked at an independent EMC lab in Pennsylvania and in 1995 I moved to Michigan to work as a test engineer in the Ford Motor Company electronics division. When Visteon was created by Ford, I moved to the Advanced Interiors group (in Visteon) as an EMC applications engineer.

Shortly after that – I transferred to the Ecostar division of Ford as the EMC senior engineer responsible for electric drives and then to Ballard with responsibilities for EMC on HEV and Fuel cell systems. When an opportunity came up at Hitachi, I joined the company as the EMC Manager.



from left to right: Barry Steltz, Paul Gojcay, Kevin McCarthy, and Jon Rykalsky

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Mark Steffka: Can you tell the readers a little about your lab and its capabilities?

Barry Steltz: The Hitachi EMC Lab is an A2LA accredited facility that is recognized by GM and Ford to perform various types' product design validation and production validation EMC tests. Our work involves testing of Hitachi in-house projects.

Mark Steffka: You have an interesting approach to staffing your EMC lab – you search for students, instead of just focusing on experienced EMC engineers. Can you tell us what do you look for when considering hiring students for your lab?

Barry Steltz: At least (and preferably junior class standing) ideally with some EMC knowledge (perhaps having taken a formal course or have had co-op experience).

Mark Steffka: What skills do you consider most important that the students should know to allow them to “hit the ground running” when they start working in your lab?

Barry Steltz: I look for them to have knowledge of basic electronic devices and circuits, how to do “dB calculations” and understanding what those calculations mean. In addition, it helps if they are familiar with the basic “terms of EMC” such as radiated emissions (RE), conducted emissions (CE), radiated immunity/susceptibility (RI/RS), and “bulk current injection” (BCI), definitions. From a theory standpoint, it's important that they know what Maxwell's equations define and why they are important. Other items such as basics of shielding, filtering and grounding are beneficial. Essentially, for an undergraduate student, I am looking for their knowledge of the items that are covered in the book *Electromagnetic Compatibility Engineering*, by Henry Ott. Later as they progress in their career and even if they move to a design engineering role, I suggest they become familiar with the book *Introduction to*

Electromagnetic Compatibility by Dr. Clayton Paul.

Mark Steffka: What do you prefer to have them “learn by doing”?

Barry Steltz: The process of EMC testing itself (such as the methodology, equipment setups, and relevant test specifications. I also like to have them explore various “design for EMC” methods including shielding, filtering and grounding approaches.

Mark Steffka: One of your current senior engineers, Kevin McCarthy, started in your lab as a student intern. This was also your first experience with hiring a student. What was your intention in looking for a student at that time?

Barry Steltz: My goal at that time was to find someone with new ideas that also had an interest in EMC. The intern or co-op program is the perfect way to evaluate a possible employee, because they are essentially in a “long term interview”, and the cost of their employment is less than a full time employee. Before I came to Hitachi, I had some experiences with students that unfortunately did not work out well, so I looked at how I could prevent those situations, and so far, I have been successful.

Mark Steffka: In the number of years since Kevin began working for you, what has worked well, and what has “surprised” you?

Barry Steltz: Three (3) out of the five (5) employees in the EMC department are or have been interns with Hitachi. Even though I have used this method of selecting employees at this and my previous employer, I was surprised that I didn't regret not hiring more experience EMC professionals.

Mark Steffka: What would you like universities to emphasize when preparing students for their career (in general or in EMC specifically)?

Barry Steltz: In general I believe all colleges should require a co-op program for their engineering students to graduate. From my experience, at a minimum, an EMC course using the Henry Ott book (previously discussed) should be available for students interested in EMC. Although some college EMC lab exposure would be desirable, the key item is knowledge of basic instrumentation used in any type of electronics lab facilities.

Kevin McCarthy

Mark Steffka: Mr. McCarthy, would you also tell us a little about yourself?

Kevin McCarthy: I received a B.S.E. in Electrical Engineering and a B.S.E. in Computer Engineering from the University of Michigan - Dearborn in 2006. I have eight years of experience in EMC testing and design here at Hitachi, and I am a member of the IEEE EMC Society.

Mark Steffka: EMC is typically a “career path” that is NOT anticipated by most engineering students. Why were you interested in this?

Kevin McCarthy: One of the reasons I took the EMC course at the University of Michigan – Dearborn was frankly, that it fit my schedule! After I was in the course, I found out that the topic piqued my interest. Since I have started at Hitachi, I realize that more students should be encouraged to participate in an intern or co-op program.

Mark Steffka: What about your education has served you well, and what has “surprised” you?

Kevin McCarthy: Courses on signals, DSP and communications have been a great benefit along with the EMC course. They complement each other well. The surprise is how much you are continually learning after you leave school.

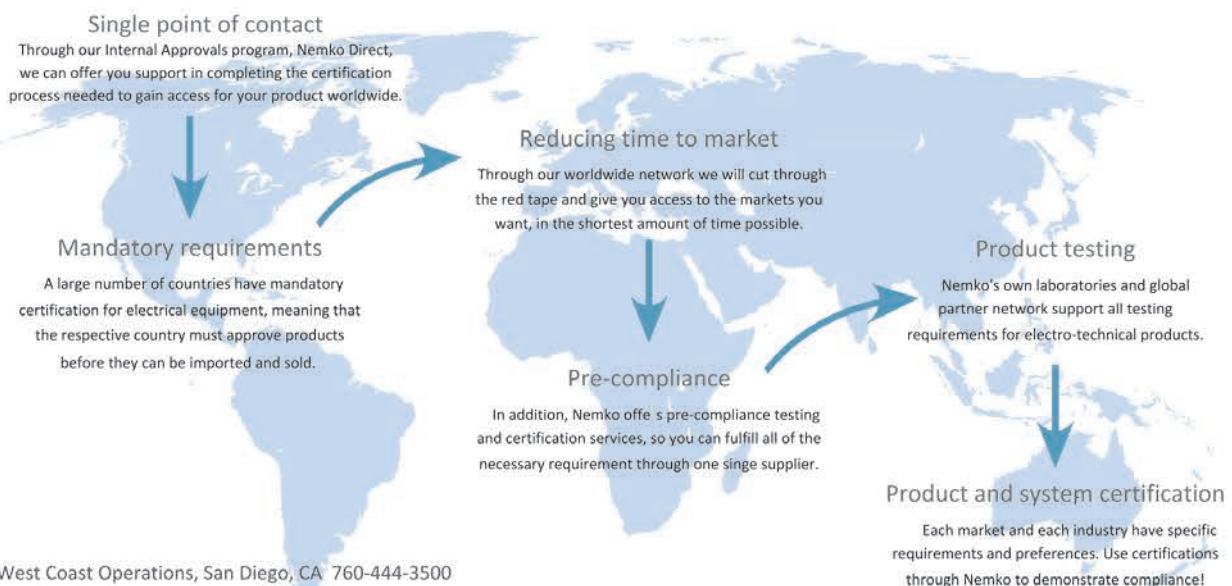
International approvals

“Nemko assists EMC Corporation to become first international company to secure India BIS registration” - August 2013

This breakthrough is a milestone for EMC and Nemko, where BIS issued its very first registration number for the category "Automatic data processing machine" for Nemko's customer, EMC Corp, for a Data Storage product: IS13252:2010. Effective January 3, 2014, all electronic products must be registered with the Bureau of Indian Standards (BIS) under the India Mandatory Registration Scheme (ICRS) before they can be sold or marketed in India.

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Mark Steffka: Why have you stayed in the EMC field?

Kevin McCarthy: Designing and testing for EMC is needed as we integrate technology into everything we do. This is especially true in the automotive industry with the continual increase in electronic control, sensors, and wireless communication on-board vehicles.

Mark Steffka: Now that you have a number of years of experience – what advice would you give to students that are completing their undergraduate education about how they should prepare for their career?

Kevin McCarthy: The best preparation for me was on-the-job experience. Get an internship or a Co-Op position and work hard at learning from experienced engineers.

Mark Steffka: What are the biggest challenges that you experience on a typical basis in your EMC work?

Kevin McCarthy: Some challenges include implementing new test stands, finding ways to improve test capabilities, and helping to solve EMC issues that arise during component testing. These are areas that can benefit from students' having basic EMC lab work as a part of their education.

Mark Steffka: What would you recommend to new graduates who may be considering working in EMC?

Kevin McCarthy: Ask a lot of questions and learn as much as possible from the EMC community. There are a lot of knowledgeable people that are willing to help you in getting started with EMC.

Mark Steffka: How do you stay on top of the current advances in EMC?

Kevin McCarthy: By attending the Symposium, EMC Fest and the occasional local chapter meetings.

Mark Steffka: What is the best part of your job?

Kevin McCarthy: That it's hands-on and it's always presenting interesting problems to solve.

Jon Rykalsky

Mark Steffka: You are in the process of completing your studies, is that correct?

Jon Rykalsky: Yes, I am attending the University of Michigan - Dearborn and am pursuing my bachelor degree in Electrical and Computer Engineering.

Mark Steffka: In the few months since you've started here, what have you learned that you consider most important to your work?

Jon Rykalsky: I have learned details about the various tests that EMC labs perform such as BCI, electrostatic discharge (ESD), and the methods for conducted and radiated conditions. I have also learned about the various types of equipment used in these tests as well as how they work together.

Mark Steffka: Why were you interested in pursuing a job in an EMC lab?

Jon Rykalsky: I was most interested due to the following reasons – it's a "hands on" opportunity, it gives me a chance to understand why (and when) calculations and measurements don't seem to match up, and EMC is an expanding field, especially in automotive systems due to more electric components on vehicles.

Mark Steffka: What has "surprised" you about this job?

Jon Rykalsky: I was surprised to find out that although to outsiders EMC is a relatively unknown topic; it is actually much larger than I thought. Not only do more people than the EMC lab team know about it, but even on a national

scale there are always EMC events going on as well as EMC dedicated magazines.

Mark Steffka: How do you see the work you've done in the lab helping you in your studies?

Jon Rykalsky: It definitely helps in circuit classes. I recently had a circuit design class and one of the points of emphasis when doing our projects was to avoid large ground loops and try to use shorter wires. Also on a more general scale, it has helped with being a part of a team as well as learning to find things on my own.

Mark Steffka: What skills have you acquired that you feel will make you a better engineering student?

Jon Rykalsky: Having to follow directions from multiple sources. For example a specification referencing multiple ISO standards. Sometimes these directions seem to be saying different things but you have to figure out what the goal is. Getting more experience with this helps when looking things up and doing research.

Mark Steffka: How does the classroom experience compare with the EMC lab experience?

Jon Rykalsky: Courses should include more exposure to engineering standards in the classroom, because that is what lab work is like. The difference I do see is due to financial resources. Classroom experiments are typically very inexpensive and basic, whereas professional lab projects use expensive EMC chambers, "top of the line" spectrum analyzers, signal generators, etc. The advanced equipment is key to obtaining detailed results instead of in the classroom, the experiment results were based more on general changes.

Mark Steffka: What are your additional thoughts or advice?

Jon Rykalsky: I think EMC is definitely a topic for students to look into. If possible, they should take a course in it, but there are also other ways to learn about it. It is a growing field and even if an EMC specific career isn't desired, how it affects other aspects of electrical engineering will help.

Paul Gojcay

Mark Steffka: Please tell us about your background.

Paul Gojcay: I am a graduate of Oakland University with and received a degree in Electrical Engineering in 2012 (I was hired in as an intern at Hitachi's EMC lab in the summer of 2011). My training and role as an intern certainly helped me gain a full time position within the company upon graduation.


Mark Steffka: It is my understanding you did not have an opportunity to take a formal EMC course. What aspects of your education have helped you in your EMC work and what suggestions do you have?

Paul Gojcay: Although I had exposure to many of the concepts and theory that is used in EMC work (primarily in physics and circuits courses), much of the work I am doing now is lab work – and this is something that really provides a different perspective than the classroom experiences.

Mark Steffka: Does your university have a formal EMC course?

Paul Gojcay: Yes, it happens to be a graduate level course. One thing that I

think could help at the undergraduate level is to perhaps have some EMC content in various courses.

Well – there's really nothing more to say! I hope this discussion on what EMC employers are looking for and how students can prepare for jobs in EMC has helped you. As usual, if you have comment or questions you'd like to share about your experiences, please contact me. 

(the author)

MARK STEFFKA, B.S.E., M.S.

is a Lecturer (at the University of Michigan - Dearborn), an Adjunct Professor (at the University of Detroit – Mercy) and an automotive company Electromagnetic Compatibility (EMC) Technical Specialist. His university experience includes teaching undergraduate, graduate, and professional development courses on EMC, antennas, and electronic communications. His extensive industry background consists of over 30 years' experience with military and aerospace communications, industrial electronics, and automotive systems.

Mr. Steffka is the author and/or co-author of numerous technical papers and publications on EMC presented at various Institute of Electrical and Electronics Engineers (IEEE) and Society of Automotive Engineers (SAE) conferences. He has also written about and has been an invited conference speaker on topics related to effective methods in university engineering education. He is an IEEE member, has served as a technical session chair for SAE and IEEE conferences and has served as an IEEE EMC Society Distinguished Lecturer. He holds a radio communications license issued by the United States' Federal Communication Commission (FCC) and holds the call sign WW8MS. He may be reached at msteffka@umich.edu.



September 24, 2013: Mark Steffka's University of Michigan class on Electromagnetic Compatibility - a real-live view of THE Chalkboard with special visitor Mr. Henry Ott (far right).

Wireless Certification in the Land of the Rising Sun

BY MIKE VIOLETTE

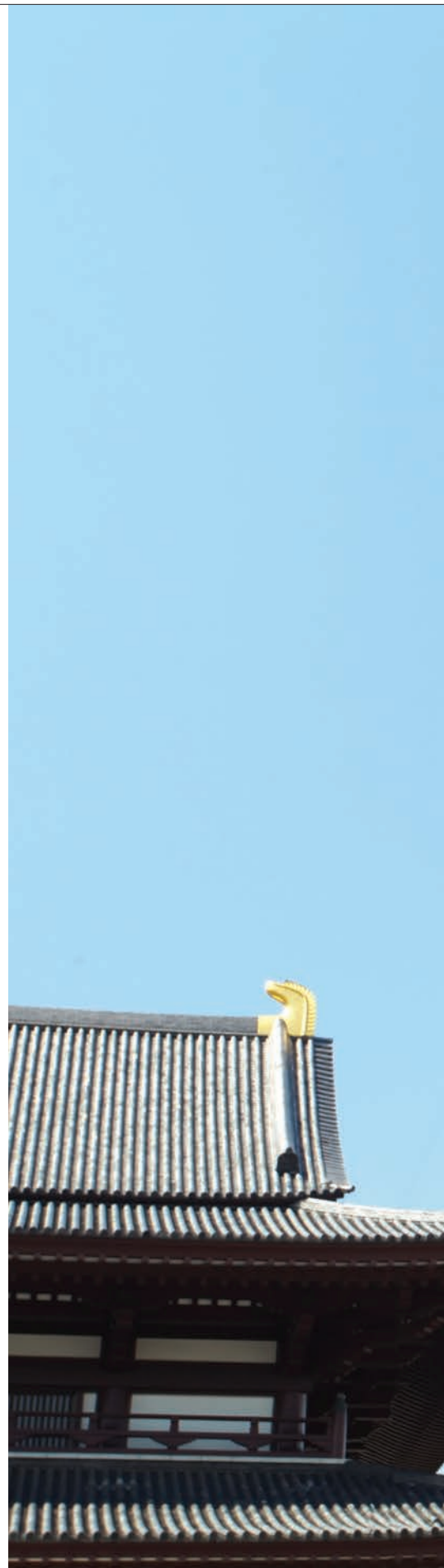
The first broadcasting station in Japan went on-air in 1925, a scant five years after the first radio station went live in the United States. A year later, Nippon Hōsō Kyōkai (NHK) was chartered by the Japanese government and is still the official public broadcast entity.

The build-out of NHK's network into the Pacific was extensive in the 1930s and during the early years of WWII and followed the expansion of Japan's imperial armed forces across the Pacific. "Tokyo Rose," a *nom d'aether* attributed to several different NHK "correspondents," was a famous voice of propaganda that teased and titillated US troops in the Pacific. After the war and during the subsequent occupation by Allied forces, all radio broadcasting was controlled by the U.S. and for some years international broadcasting by NHK was severely limited.

The rise of broadcasting naturally created a need for radio receiving equipment and the radio

manufacturing industry in Japan was heavily influenced by Mr. Tokuji Hayakawa, who developed the first tube radio set (patterned after more expensive import versions).¹ Hayakawa-san was a creative, driven individual who began his long career of design and development with the patented "Ever-Sharp Pencil" (a breakthrough in the development of mechanical pencils—engineers everywhere should thank him for that). After shifting from pencils to power tubes, Hayakawa appropriated the word "SHARP" for his growing radio business and developed numerous models of broadcast

1. A fascinating history of the Sharp Corporation can be found here: http://sharp-world.com/corporate/img/info/his/h_company/pdf_en/all.pdf





receivers under that name, now a global brand for everything from components, cameras, phone and solar products. In 1950, the first legislation governing the operation of radio stations (Law Number 131) came into being. This wide-reaching *Radio Law* may be considered a parallel of the Communications Act of 1934, which established the Federal Communications Commission (FCC). The Japan Radio Law has been amended numerous times and was followed, in 1984, by the *Telecommunications Business Law* (Law Number 86). Both the Japan Radio Law and the Telecommunications Business Law are key parts of the requirements for certification of telecommunications products in Japan.

Under the Japanese system, there are specific levels of regulations that govern approvals for wired and wireless equipment. They are structured as specific laws and ordinances (Table 1). The Ordinances contain the technical requirements and the process for approvals (conformity assessment).

Certification Body processes are outlined in the “Ordinances regarding Conformity Assessment Procedures” which applies to all RCBs, including MIC’s own TELEC. Another critical ordinance is MIC

Notice 88, January 26, 2004 (Test Methods and Appendix to Post of the Ministerial Ordinance No. 37, November 21, 1981). These documents contain the test methods for the various types of radio equipment. Original Japanese documents are available at the following URL: www.tele.soumu.go.jp/j/sys/equ/tech/type/index.htm. Very few official English-language texts of the test methods are available, which has been a challenge for the English-speaking-only test industry.

One source of documents that can be used *for reference purposes* are available through the Association of Radio Industries and Businesses (ARIB). This organization has translated several of the common documents, however, it is important to note that the MIC procedures must be referenced or *cross-referenced to equivalent methods*. This cross-reference protocol was agreed to because of the challenge of translation of test methods and procedures.

MUTUAL RECOGNITION AGREEMENTS OPEN MARKETS

These past dozen years or so have seen the successful implementation of *Mutual Recognition Agreements and Arrangements* across multiple

economies, spurring trade between the United States, European Union and Asia. MRAs, as they are called, are high-level agreements that are signed by regulatory bodies in each economy.

The MRA between the United States and Europe is an example of one of the most successful cross-barrier agreements for technology product, allowing manufacturers to test products in their home countries for international markets. This has added to the expansion of global trade since the arrangement was first implemented in December 1998. For the past fifteen years, the trade between the US and Europe has expanded many fold, notably in the critical industries of high technology, electronics and communications. Coupled with the EU’s CE Marking, the MRA has dramatically increased market access for domestic and European manufacturers.

The US-Japan Mutual Recognition Arrangement has been active for the past five years, with real implementation coming on-line around 2010. Negotiated, in part, under the umbrella of the multi-lateral Asia-Pacific Telecommunications MRA, the bilateral agreement was staked out to cover both wireless and wired telecom products and is the sixth such MRA covering certification.

	Radio Equipment	Terminal Equipment
Laws	Radio Law	Telecommunications Business Law
Ordinances regarding Technical Requirements	Ordinance regulating radio equipment (Radio Regulatory Commission Regulation No. 18, 1950)	Ordinance concerning terminal facilities, etc. (MPT Ordinance No. 31, 1985)
Ordinances regarding Conformity Assessment Procedures	Ordinance concerning technical regulations and conformity certification of specified radio equipment (MPT Ordinance, referred to as “Certification Ordinance”)	Ordinance concerning technical conditions and compliance approval of terminal equipment (MIC Ordinance No 15, 2004, referred to as “Approval Ordinance”)

Table 1

Certification for the Japan market, regulated by Japan's Ministry of Internal Affairs and Communications (MIC) is directly available for US manufacturers and laboratories.

This has opened the door for manufacturers to get access to the Japan technology market, and "is expected to enhance speed to market, and lower costs in the \$2.2 billion trade in telecommunications equipment between the two countries. Japan is now the fifth largest export market for U.S. telecommunications equipment manufacturers, and this agreement is particularly important given the innovation and fast paced growth that characterized both markets."²

Under the terms of the US-Japan MRA, Recognized Certification Bodies (RCBs) have the authority to issue certifications directly. The process lays out the now well-worn path that Certification Bodies have been taking for years: accreditation by an approved Accreditation Body and Designation by (in the US) NIST. The agreement specifies the objective "... to designate private-sector entities in their respective territories to test and certify telecommunications terminal

2. <http://www.ustr.gov/about-us/press-office/press-releases/archives/2007/november/us-japan-telecom-mutual-recognition-agre>

and radio equipment as meeting the technical requirements of the other country."

Products covered by the MRA include unlicensed and licensed devices. The range of the agreements covering both regulatory structures is summarized in Table 2 (from the MRA).

Note the designation of "Specified Radio Equipment" which is a listing of devices according to function in each of three categories. In Japanese parlance, every radio device is a somewhat anachronistic "Station". The three categories of equipment are as follows:

Category 1: Unlicensed station: 17 classes (Specified Radio Equipment specified in Article 38-2, paragraph 1, item 1 of the Radio Act). These are generally low power (< 1W) devices.

Category 2: Licensed station (Blanket License): 31 classes (e.g., mobile phones) (Specified Radio Equipment specified in Article 38-2, paragraph 1, item 2 of the Radio Act).

Category 3: Licensed station (Others): 75 classes (e.g., basestations) (Specified Radio Equipment specified in Article 38-2, paragraph 1, item 3 of the Radio Act).

PROCESSES

The process for Japan Certification has some unique aspects, at least in terms of practice (when compared to the US/Canada system and the Notified Body process for the EU). This is largely because of the way the system evolved; the radio testing and certification community in Japan is relatively close-knit and the processes were built around the notion of trust, confidence and mutual agreement within that community.

Some of the primary characteristics of the Japan certification system, in practice, are:

1. The RCBs have the authority to directly certify, using forms and formats of their own design.
2. The Certification Number is required on the product, but the number is issued by the RCB (contrast that with the system in the US wherein the grantee chooses the FCC ID and the system in Canada where IC issues the IC number. Further contrast that with the notion of the TCF number under the EU Directives)
3. There is no accreditation requirement for the test lab. The RCB must establish "trust" with the test provider. This became a bit of a complication when implementation discussions were underway; the

United States	Japan
Any equipment subject to certification, as defined in 47 CFR 2.907, that falls with the scope of the 47 CFR parts listed in paragraph 2 of the Section I of the Annex, except Unintentional Radiators and Industrial, Scientific and Medical Equipment as defined in 47 CFR 15.3(z) and 47 CFR 18.107(c), respectively.	<ol style="list-style-type: none"> 1. Any equipment defined as Specified Radio Equipment in Radio Law (Law No. 131, 1950) and amendments thereto; and 2. Any equipment defined as Terminal Equipment in Telecommunications Business Law (Law No. 86, 1984) and amendments thereto.

Table 2

There is an allowance for equipment in Japan that does not need any certification. These devices can radiate anywhere in the spectrum as long as the field strength limits at 3 m are very, very low.

US system is heavily dependent on accreditation and the 'chain of authority'.

4. US RCBs are obligated to report to the MIC the certifications performed in a given month. All information on the device (reports, manuals, technical information) stays with the RCB and there is no formal "dismissal" process as with the FCC. Compliance is typically monitored once a device hits the Japan market.
5. MIC grants more 'interpretation' powers to the RCB. This is largely due to the manner in which the system evolved.

DOCUMENTS REQUIRED FOR CERTIFICATION

Many of the same documents and information required for Japan certification are also required for other regulatory regimens. The primary information is as follows:

1. Application Form
2. Agency Letter (if needed)
3. Quality Management System Declaration and Letter of Quality Control Management
4. Manufacturer's ISO 9001 Certificate
5. Construction Protection Confirmation
6. Schematics, BOM and Block Diagram
7. Antenna Information
8. Internal and External Photos
9. Label Information and Location
10. Test Report
11. User's Manual

Note: RF exposure requirements are currently being developed with potential implementation in the first half of 2014. It is understood that Japan will follow, more or less, the European model for dealing with RF hazards.

There are a few items that are somewhat unique, notably the requirement for directly addressing the manufacturer's quality assurance processes. An ISO 9001 certificate is usually all that is necessary, but lacking that, a definitive statement and/or process that address QA management needs to be supplied. Another requirement is the "Construction Protection Confirmation" which states that the radio section of the device must not be easily opened, must have a unique type of fastener, or must be manufactured such that opening the enclosure would render it inoperable (by potting, ultrasonic welding or gluing).

There are also requirements for measuring *all* parameters when the input power to the device is subject to +/-10% input voltage variation. The input voltage variation test can be

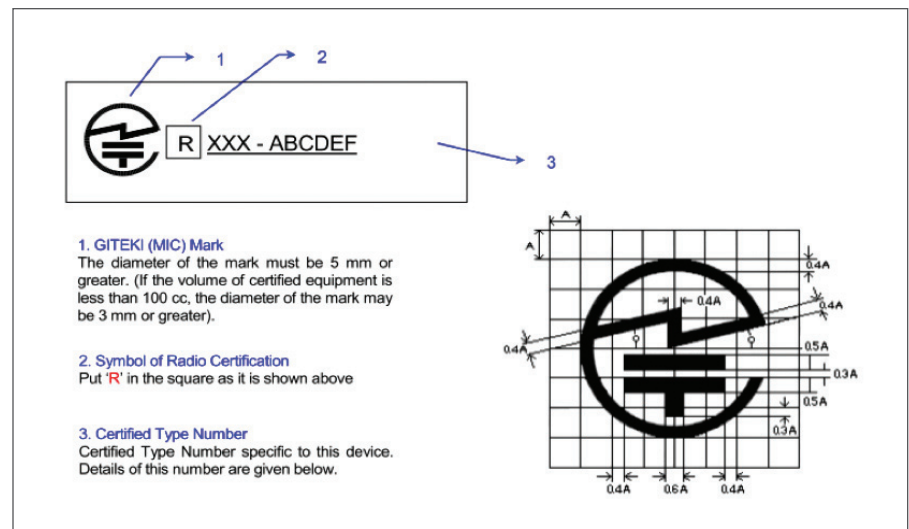
limited, however, if the unit employs a regulator that keeps the output voltage to less than 1% variation when the input is varied by +/-10%. This is not a very difficult control, frankly, and can limit the number of tests that have to be performed on the device.

There are also specific variations on output power, wherein the device must "hold" the power between plus 20% minus 80% variation across the operating band.

There is an allowance for equipment in Japan that does not need any certification. These devices can radiate anywhere in the spectrum as long as the field strength limits at 3 m are very, very low (on the order of Class B emissions limits). These devices are referred to as "extremely low power radio stations."

MODULAR APPROVALS

The Japan regulations refer to radio modules as stations that are "Independent of Host" and allow modular approvals. This simplifies



Japan label

The access for obtaining wireless certifications for Japan has been opened up significantly. The opening of these requirements has also led to further cooperation and participation in global forums.

the devices approvals for many end-integrators. The module must be tested as a stand-alone device and must be labeled with the certification number assigned by the RCB. There is no provision for the host device to be marked in any way, however additional guidelines are being developed for modular approval certification.

PERMISSIVE CHANGES

The process for handling permissive changes is similar to the FCC/IC process, that is, a certain limited number of changes can be applied to the device before a new certification number is needed, namely:

1) additional antennas (as long as EIRP limits are observed), and 2) changes in RF components that occupy the same footprint, perform the same function, and don't alter the characteristics of the radio.

Since the certification process is generally a close coordination between the applicant (or agent of the lab), the process for amended certificates is

usually *not* filed with MIC as the basic information on the certificate is not supposed to change (operating power, frequency of operation, model name).

EQUIPMENT CONNECTED TO THE PUBLIC NETWORK

The Telecommunications Business Law, introduced earlier in this article, is primarily directed at TTE equipment and other devices that connect to the public networks. Common examples include wired TTE equipment as well as wireless devices (such as mobile phones). In addition to the requirements for conformance with the Radio Law, wireless phones and devices that provide public connectivity (public "hotspots" that are common in coffee shops and the like) must also conform to the Telecommunications Business Law. The primary requirements include protocols and related matters that dictate device connection to the public network. These devices must also have an additional label element, which consists of a "T in a box".

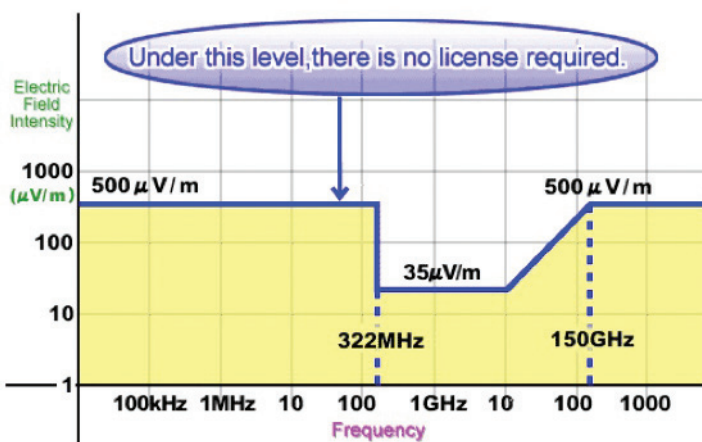
A NOTE ON ELECTROMAGNETIC COMPATIBILITY

EMC in Japan is largely unregulated and is under the auspices of the Voluntary Control Council for Interference (VCCI), which has been operating with great effectiveness since 1985. The requirements deal solely with emissions from equipment and, as the name of the council states, compliance is voluntary. Most adherents to the VCCI process use it for market-acceptance. As one might imagine, the VCCI mark is very important in the Japanese consumer marketplace.

SUMMARY

The access for obtaining wireless certifications for Japan has been opened up significantly. The United States has joined the European Union in signing an MRA that allows for mutually acceptable conformity assessment procedures. In addition to the simple fact that market access has improved for Japanese and American manufacturers, the opening of these requirements has also led to further cooperation and participation in global forums, such as the APEC TEL MRA Working Group, whose purpose is to examine ways to enhance the MRAs and look at matters that arise from the regulatory regimens, representing a firm example of cooperation and underscoring the access that powers global trade in the high technology industry. 

Figure: Tolerance of the Electric field Intensity of the Extremely Low Power Radio Station at the distance of 3m



Extremely low power radio stations

(the author)

MIKE VIOLETTE
is Director and Founder
of American Certification
Body. He can be reached at
mikev@acbcert.com.





A 1kV Discharge Directly onto a Staple Leads to Increased Energy Penetration Inside Metallized Static Shielding Bags

BY BOB VERMILLION, CPP/FELLOW
CERTIFIED, ESD & PRODUCT SAFETY ENGINEER-INARTE

Editor's Note: Due to the overwhelming amount of positive feedback from the September 2013 issue of *In Compliance* (pp. 42-48), a follow-up article with additional lab testing by the author was necessary to respond to an aerospace prime.

Thank you for your informative article on "Pin Holes & Staples Lead to Diminished Performance in Metallized Static Shielding Bags." Have you considered what happens if there is an ESD discharge to the staple in a bag?

Outstanding question! If the reader will recall from last month's article, initial lab testing was conducted by the author for Type III static shielding bags to ANSI/ESD STM11.31-2012. According to the ESD Association, "This standard test method provides a method for testing and determining the shielding capabilities of electrostatic shielding bags."¹

The reader may remember from last month's article that ESD shielding bag excessive wear, stapling and pin holes can pose device protection risks. The size and magnitude of the pin holes influences bag attenuation from a high voltage discharge (HVD). In the previous study, stapled Type III static shielding bags were subjected to 1kV discharges in close proximity to staple(s) or pin holes. As a reference

point, the calibrated discharge (metal to metal) generated 49,794.96 nJ. The first test consisted of a new static shielding bag (free of staples) that was subjected to six 1kV discharges; the average energy penetration was 17.95 nJ (Figure 2 right, page 32). According to Mil-PRF-81705E, passing equals 10nJ Max, ANSI/ESD S11.4, passing equals <20 nJ and for ANSI/ESD S541-2008, passing equals <50 nJ. Therefore, the bag passed S11.4 & S541.

1. ESDA website for Standards



Figure 1

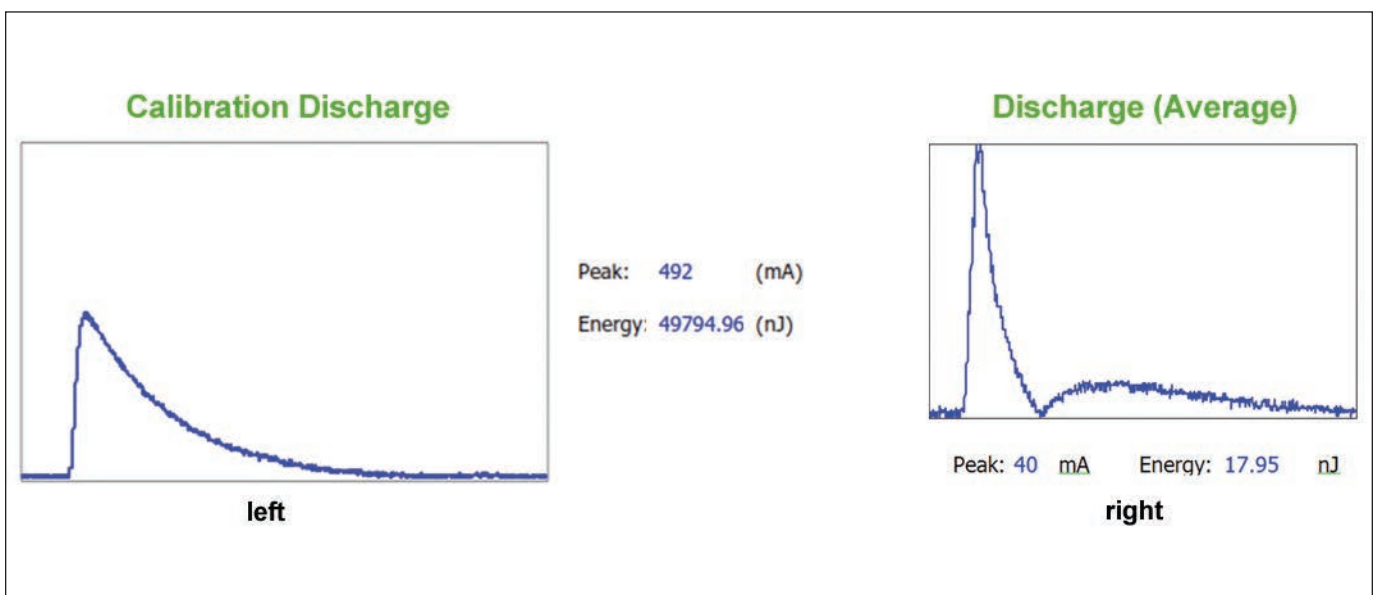


Figure 2



Figure 3

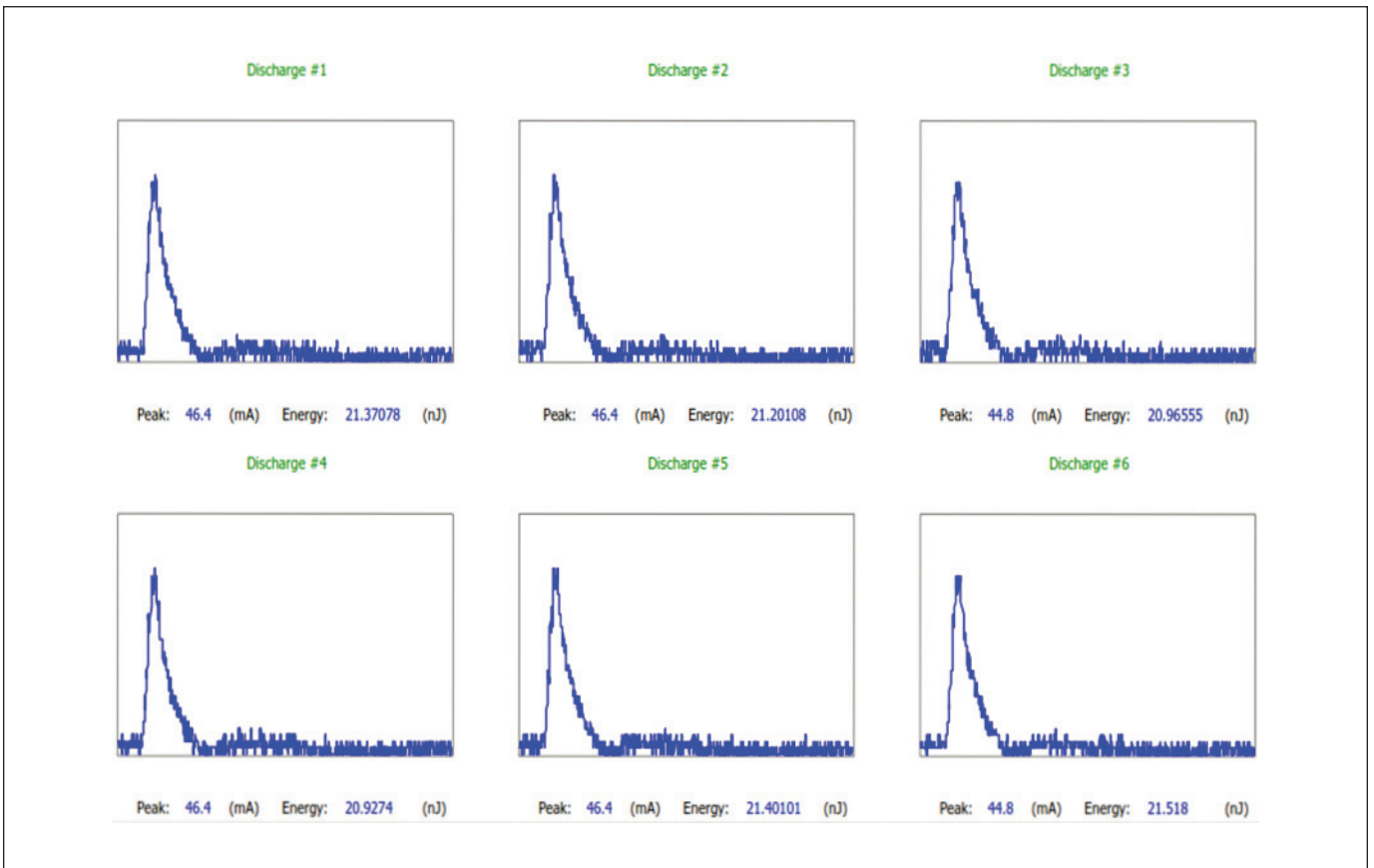


Figure 4

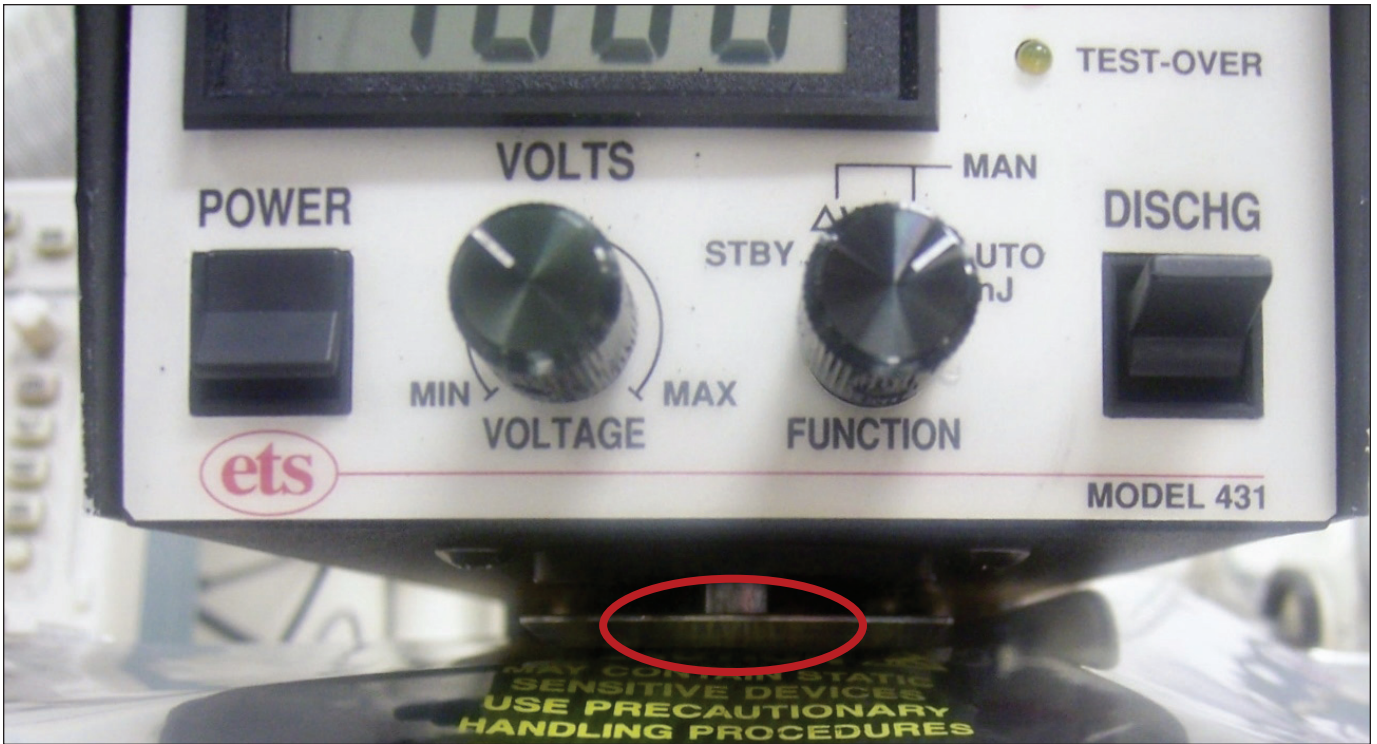


Figure 5

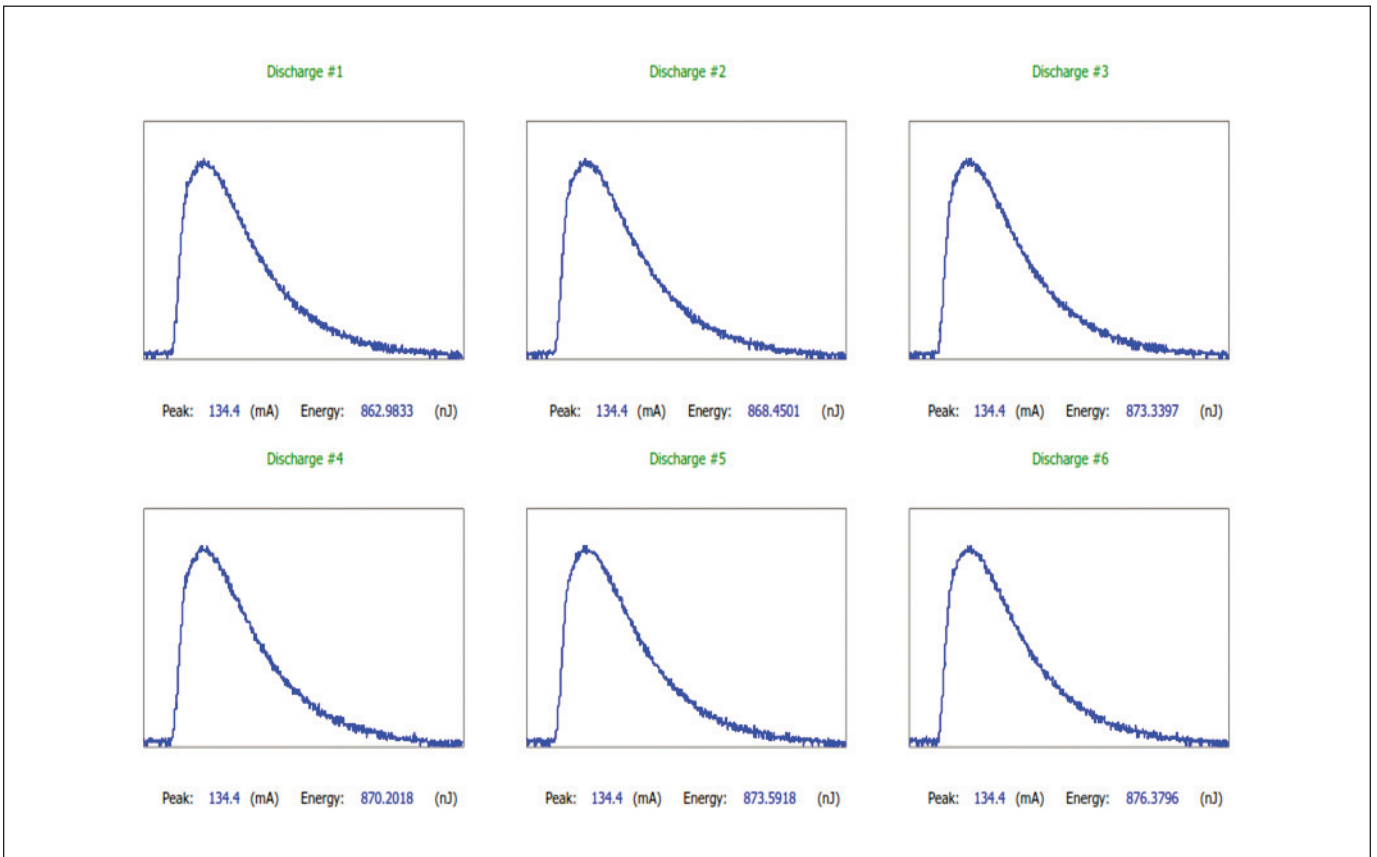


Figure 6



Figure 7

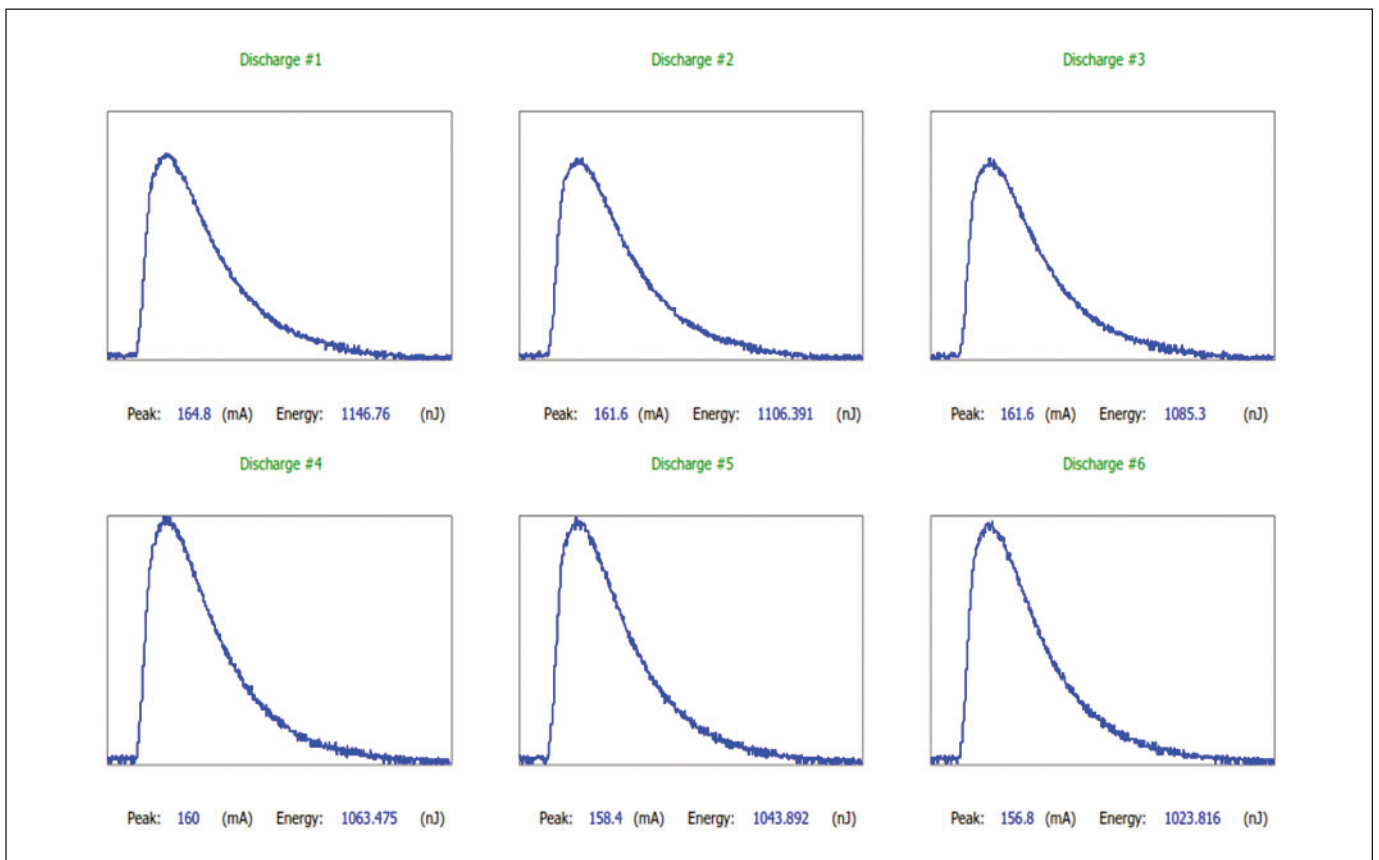


Figure 8

PeakCurrent (492mA)			No Staples			PeakCurrent (492mA)			Staple - Offset		
Bag 1	mA	HVD	Bag 1	nJ	HVD	Bag 2	mA	HVD	Bag 2	nJ	HVD
1	40.00	1000v	1	17.98	1000v	1	46.40	1000v	1	21.37	1000v
2	40.40	1000v	2	18.06	1000v	2	46.40	1000v	2	21.20	1000v
3	40.00	1000v	3	17.81	1000v	3	44.80	1000v	3	20.97	1000v
4	40.00	1000v	4	17.96	1000v	4	46.40	1000v	4	20.93	1000v
5	40.40	1000v	5	17.81	1000v	5	46.40	1000v	5	21.40	1000v
6	40.40	1000v	6	18.06	1000v	6	44.80	1000v	6	21.52	1000v
Average	40.20	No Holes	Average	17.95	No Holes	Average	45.87	Stapled	Average	21.23	Stapled
Median	40.20		Median	17.97		Median	46.40		Median	21.29	
Minimum	40.00		Minimum	17.81		Minimum	44.80		Minimum	20.93	
Maximum	40.40		Maximum	18.06		Maximum	46.40		Maximum	21.52	
St. Dev.	0.22		St. Dev.	0.12		St. Dev.	0.83		St. Dev.	0.24	
PeakCurrent (492mA)			HVD - Off Center Stapled			PeakCurrent (492mA)			HVD - Center Stapled		
Bag 3	mA	HVD	Bag 3	nJ	HVD	Bag 4	mA	HVD	Bag 4	nJ	HVD
1	134.4	1000v	1	863.0	1000v	1	164.8	1000v	1	1146.8	1000v
2	134.4	1000v	2	868.5	1000v	2	161.6	1000v	2	1106.4	1000v
3	134.4	1000v	3	873.3	1000v	3	161.6	1000v	3	1085.3	1000v
4	134.4	1000v	4	870.2	1000v	4	160.0	1000v	4	1063.5	1000v
5	134.4	1000v	5	873.6	1000v	5	158.4	1000v	5	1043.9	1000v
6	134.4	1000v	6	876.4	1000v	6	156.8	1000v	6	1023.8	1000v
Average	134.4	Stapled	Average	870.8	Stapled	Average	160.5	Stapled	Average	1078.3	Stapled
Median	134.4		Median	871.8		Median	160.8		Median	1074.4	
Minimum	134.4		Minimum	863.0		Minimum	156.8		Minimum	1023.8	
Maximum	134.4		Maximum	876.4		Maximum	164.8		Maximum	1146.8	
St. Dev.	0.0		St. Dev.	4.7		St. Dev.	2.8		St. Dev.	44.5	

Table 1: Individual Capacitive Probe 1kV Discharge Results

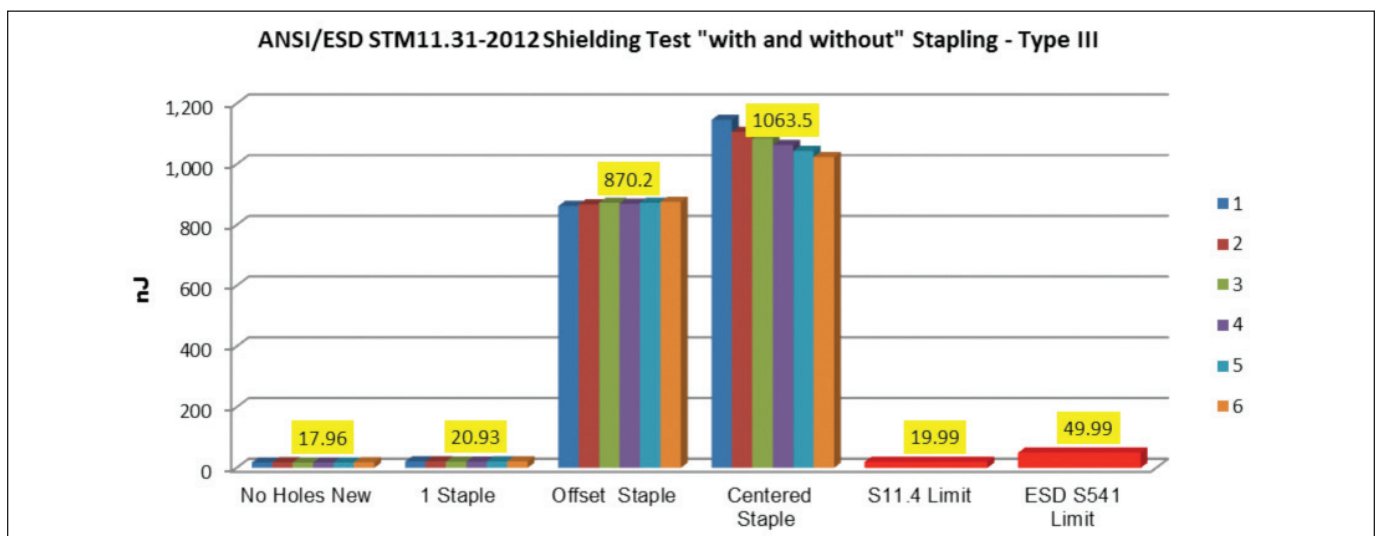


Table 2

One could conclude that stapling a bag is an egregious act for ESD control. The author welcomed the defense contractor's inquiry which in turn prompted additional analysis. One may not be able to prevent pin holes or puncturing of a static shielding bag, but the unconventional act of stapling bags can be reined in so as not to compromise the integrity of an ESD control program.

Subsequently, the author subjected a stapled bag to ANSI/ESD STM11.31 testing with a staple in close proximity to the capacitive probe as illustrated in Figure 3 (page 33).


Therefore, an average discharge energy (nanojoules) seen inside the bag from the offset staple in close proximity to the capacitive probe at 1kV discharge measured was 21.23 nJ.

In this brief overview, another stapled bag was positioned under the ANSI/ESD STM11.31 capacitive probe fixture, slightly offset, before undergoing a 1kV discharge (Figure 5, page 34). A whopping 876.38 nJ penetrated the bag when a metal capacitive probe discharged onto the metal staple.

Consequently, final testing took place when the capacitive probe was firmly clamped into place and directly centered over the staple as illustrated in Figure 7 (page 35). And, as Figure 8 (page 35) illustrates, an impressive 1078.27 nJ penetrated the bag!

From Table 1, the reader can review the entire data tested at 12%RH, 73.4°F after 48 hours of preconditioning.

In short, one could conclude that stapling a bag is an egregious act for ESD control. The author welcomed the defense contractor's inquiry which in turn prompted additional analysis. One may not be able to prevent pin holes or puncturing of a static shielding bag, but the unconventional act of stapling bags can be reined in so as not

to compromise the integrity of an ESD control program. The reader can review the previous article on the risks of pinholes and staples at <http://www.incompliancemag.com/DigEd/inc1309>. 

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(the author)

BOB VERMILLION, CPP/FELLOW

CERTIFIED ESD & PRODUCT SAFETY ENGINEER-INARTE

is a subject matter expert in ESD mitigation of materials & packaging and is an ESDA Standards Committee Member. In 2010, Bob was the First to Present on Suspect Counterfeit ESD Packaging in the Supply Chain at the NASA-QLF. RMV, a NASA Industry Partner, is headquartered onsite at NASA-Ames Research Center. RMV is a NASA approved ESD testing lab. Bob publishes numerous articles and white papers on advanced materials, packaging non-compliance and suspect counterfeiting in manufacturing, materials handling, shipping and long-term storage for the aerospace/defense, medical and electronics sectors.

An internationally recognized author and speaker, Bob has developed professional level ESD Packaging Seminars for Cal Poly, SJSU, UC Berkeley, Loyola Marymount and Oxford University. Speaking engagements include the DOD, DOE and NASA for presenting on Supplier Issues with Materials and Packaging. RMV is a 3rd Party ESD Material Testing, Training and Engineering Company. Bob Vermillion is an active member of SAE G-19 Counterfeit Components and SAE G-21 Counterfeit Material Committees and Vice-Chair of the ESDA Aerospace WG 20.21. Bob can be reached at 650-964-4792 or email Bob at bob@esdrmv.com.





Electromagnetic Interference Shielding Effects in Wireless Power Transfer Using Magnetic Resonance Coupling for Board-to-Board Level Interconnection

In this article, we present the analysis of electromagnetic interference (EMI) shielding effects of wireless power transfer (WPT) using magnetic resonance coupling for board-to-board level interconnection. Board-to-board WPT consists of source coil, receiver coil, and load which are manufactured on printed circuit board (PCB). The coil is expressed as a simple equivalent circuit model, of which the components are calculated using the physical dimensions of the coil. It is verified that the results of model estimation in both frequency- and time-domain show a good correlation with simulated and measured results under 1GHz. Voltage transfer ratio (VTR) of board-to-board WPT was achieved to be 0.49. In addition, EMI shielding effects in WPT with materials such as ferrite and metal film is analyzed using verified model. The shielding effects of each film in WPT are compared by observing their magnetic field distribution.

BY SUKJIN KIM, HONGSEOK KIM, JONGHOON J. KIM, BUMHEE BAE,
SUNKYU KONG AND JOUNGHO KIM

The wireless power transfer (WPT) technology is recently applied to multiple applications such as wireless charging systems for mobile phones, laptops and other handheld devices [1]. With miniaturization, this technology can be applied to more various applications such as board-to-board level interconnections, which mean

that power is transferred from upper source board to lower receiver board, for mobile devices. Conventionally, board-to-board level power interconnections have been designed using connectors; however, as more and more components are mounted on the tiny board, the number of power lines increases dramatically, while the number of signal lines even

exceeds that of power lines. Therefore, instead of using power lines, the required power needs to be transferred wirelessly.

The simplified diagram of WPT using magnetic resonance for board-to-board level interconnection is shown in Figure 1 (page 40). The board of power source consists of inductive coils

In this article, wireless power transfer (WPT) using magnetic resonance coupling for board-to-board level interconnection is introduced, and especially we focus on the EMI shielding effects.

and DCAC inverter, while that of power receiver consists of inductive coils, rectifier, and DC-DC converter. In the view of performance of the board-to-board WPT, the magnetic resonant coupling between the inductive coils is a key factor because it dominantly determines the overall performance of the system: the magnetic resonance in an inductively coupled system efficiently increases the amount of magnetic flux linked between coils, which results in the significant improvement of voltage transfer ratio (VTR) [2][3].

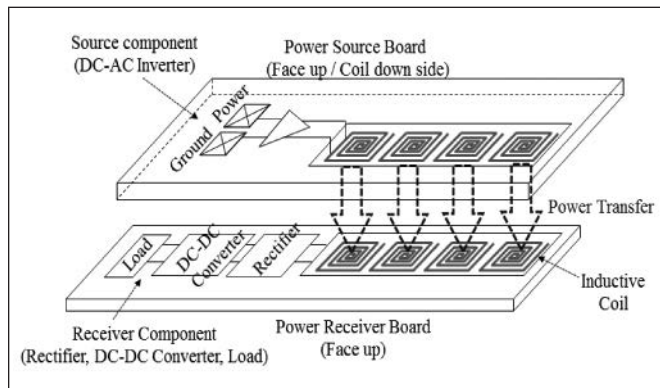


Figure 1: The simplified diagram of wireless power transfer using magnetic resonance for board-to-board level interconnection

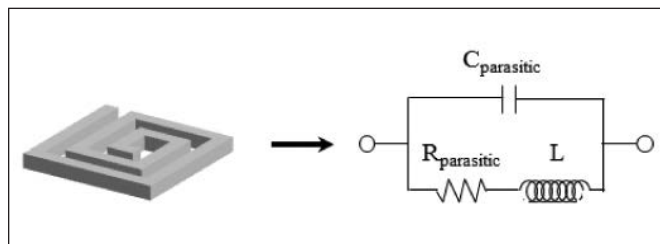


Figure 2: Conventional equivalent circuit model of spiral coil

Physical Dimension	Value
Exterior Diameter, d_e	10 mm
Interior Diameter, d_i	3.4 mm
Number of Turns, N	5 turns
Metal Width, w	0.5 mm
Metal Space, s	0.2 mm
Metal Thickness, t	0.018 mm

Table 1: Physical dimensions of spiral coil

The specification of the system is indicated by the following three parameters: resonant frequency, self-inductance of the coils, and electromagnetic interference (EMI) characteristic. First of all, resonant frequency is determined by the self-inductance of the coil and the tuning capacitance. Secondly, self-inductance of the coil is determined by the physical dimension of the coil. Lastly, EMI characteristic is affected by attaching shielding materials such as ferrite and metal film that could change self- and mutual inductance.

In this article, WPT using magnetic resonance coupling for board-to-board level interconnection is introduced, and especially we focus on the EMI shielding effects. For analyzing EMI shielding effects, we suggest simple equivalent circuit model which consists of self-inductance, parasitic resistance, and capacitance [4][5]. The coil for board-to-board WPT, designed as a spiral type, is manufactured on printed circuit board (PCB) for experimental verification and comparison with the model. The model is successfully verified by the 3D field simulated and measured results under 1GHz. We use verified model and 3D field simulator for investigating EMI shielding effects in WPT. The shielding material affects not only EMI shielding in WPT but also equivalent circuit model of the coil, hence the performance of WPT can be changed.

WIRELESS POWER TRANSFER FOR BOARD-TO-BOARD LEVEL INTERCONNECTION

In this section, WPT for board-to-board level interconnection is presented on the manufactured PCB. The most important component in this system is the coil, which determines VTR of the entire WPT system. Therefore, analyzing the equivalent circuit model of the spiral coil is very important, of which the parameters can be obtained by a series of calculations using its physical dimensions. The equivalent circuit model will be thoroughly explained by the equations presented below. Mutual inductance is extracted from the 3D EM simulation. Through this sequence, board-to-board WPT is manufactured on PCB. This system can be adapted to board-to-board level interconnection, in which the boards can be separated by several millimeters.

Equivalent Circuit Model of Spiral Coil

As shown in Figure 2, the spiral coil is modeled as a self-inductance, L , and a parasitic resistance, $R_{\text{parasitic}}$. In addition, the capacitance between two ports of the spiral coil is

represented as a parasitic capacitance, $C_{\text{Parasitic}}$. In order to calculate the self-inductance, the physical dimensions of the spiral coil should first be known, as listed in Table 1. From these dimensions, the self-inductance, L , is given by

$$L = \frac{\mu N^2 d_m 1.27}{2} \left[\ln \left(\frac{2.07}{\rho} \right) + 0.18\rho + 0.13^2 \rho \right] \quad (1)$$

$$d_m = (d_e + d_i)/2, \quad \rho = (d_e - d_i)/(d_e + d_i) \quad (2)$$

where d_m is the average diameter and ρ is the fill ratio [4]. The self-inductance, L , calculated by Equations 1 and 2 is 208 nH. Moreover, the parasitic resistance of the coil, $R_{\text{Parasitic}}$, is given by

$$R_{\text{Parasitic}} = \frac{l}{\sigma w \cdot t_{\text{eff}}} \quad (3)$$

$$t_{\text{eff}} = \delta \cdot (1 - e^{-t/\delta}), \quad \delta = \sqrt{\frac{1}{\pi f \mu \sigma}} \quad (4)$$

where t_{eff} is the effective metal thickness and δ is the skin depth of copper at the resonant frequency of 110 MHz [5].

From Equations 3 and 4, it can be calculated that the parasitic resistance, $R_{\text{Parasitic}}$, is 677 mΩ. In order to come up with an exact equivalent circuit, the parasitic capacitance, $C_{\text{Parasitic}}$ between the adjacent spiral lines of the coil should be calculated and taken into account. In general, however, this capacitance is negligible, since the adjacent metal lines in each turn have almost same potential. Therefore, the equivalent circuit model is represented only by the self-inductance, L , and the parasitic resistance, $R_{\text{Parasitic}}$.

Manufactured Printed Circuit Board

In the board-to-board WPT manufactured on the PCB shown in Figure 3, the source board is composed of a SMA connector, a tuning capacitor for matching the resonant frequency, and a source spiral coil. Similarly, the receiver board is composed of a tuning capacitor, a receiver spiral coil, and the same SMA connector. The measurement is conducted with the vector network analyzer to measure the S-parameters and also, with the oscilloscope to capture the time-domain waveforms at the SMA connectors.

COMPARISON AND ANALYSIS OF SIMULATION AND MEASUREMENT

In this section, the comparison between the simulation and the measurement results in the frequency-and time-domain, as well as the analysis, is presented.

Frequency-Domain

Figure 4 shows the equivalent circuit model of the WPT system for board-to-board level interconnection used for frequency-domain simulation. L_S , R_S and L_R , R_R are the self-inductances and the parasitic resistances of the source and receiver coils, respectively. The tuning capacitors connected in series to the source and receiver coils are C_S and C_R . M is the mutual inductance between the coils and k is the coupling coefficient of the coils. In this case, the new parasitic capacitance from SMA connectors used for measurement should be connected in parallel. The capacitance of SMA connector is about 1 pF which is extracted from the frequency-domain measurement.

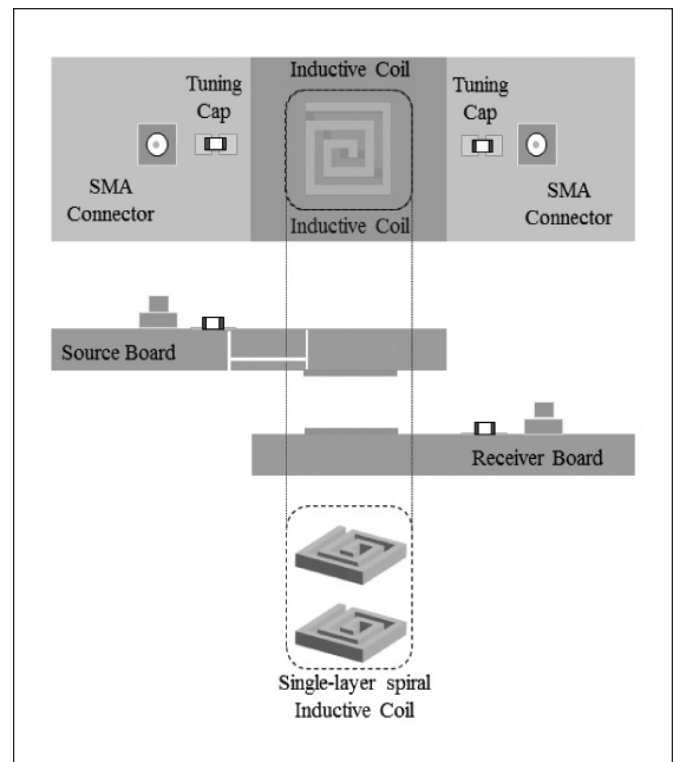


Figure 3: Wireless power transfer for board-to-board level interconnection on printed circuit board

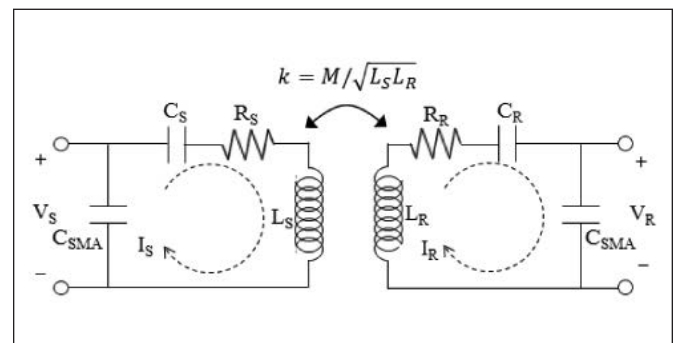


Figure 4: Equivalent circuit model of the WPT system

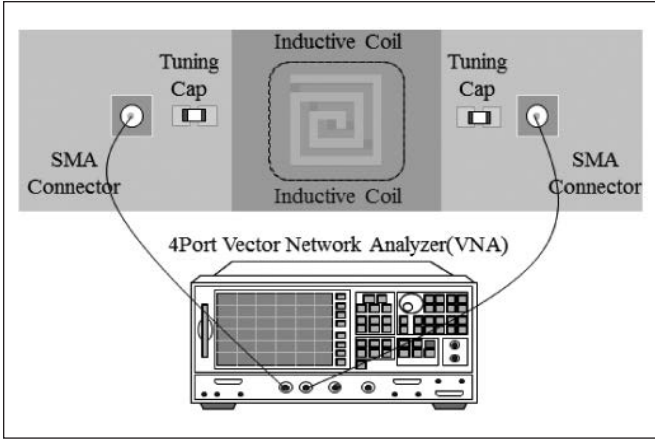


Figure 5. Frequency-domain measurement setup for the WPT system

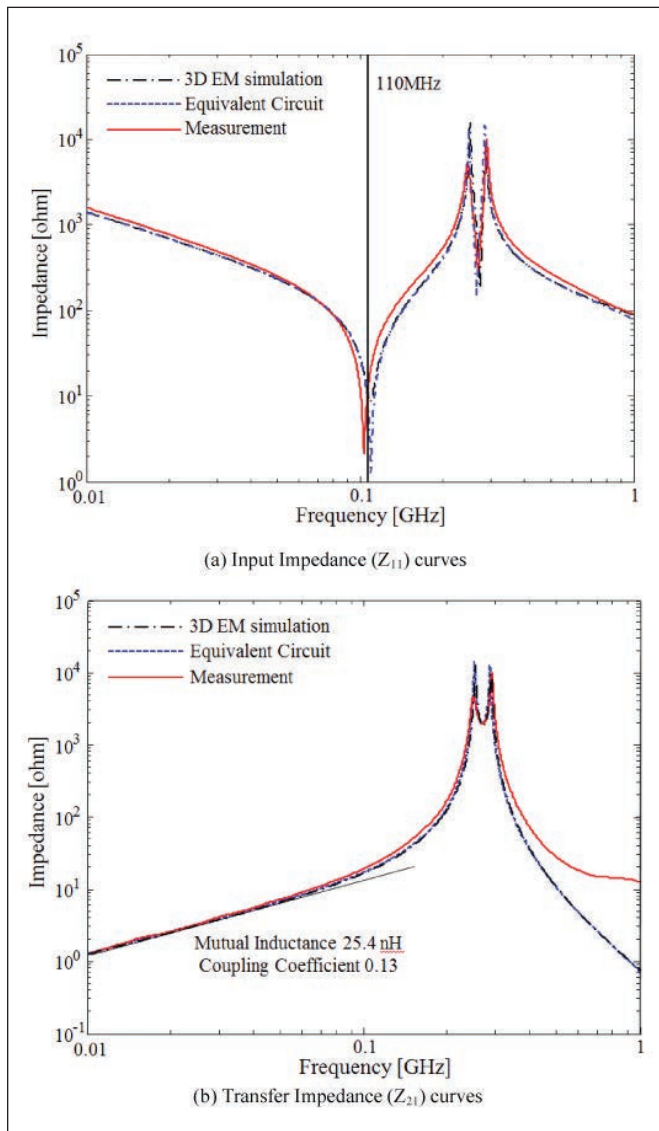


Figure 6: Input Impedance (Z_{11}) curves and transfer Impedance (Z_{21}) curves of each case at the board-to-board distance of 5mm.

For comparison, the estimation using the equivalent circuit model and the simulation using 3D EM simulator, ANSYS HFSS are performed individually. In addition, the frequency-domain measurement of the WPT system is conducted as shown in Figure 5. The results are shown in Figure 6. The depicted input impedance (Z_{11}) and transfer impedance (Z_{21}) curves of Z matrix obtained from the simulations show a good agreement with the measurement results.

From Z_{11} curve of the WPT system shown in Figure 6a, the series resonance peak, where the input impedance is minimized using the tuning capacitor, was found to be at 110 MHz, which coincides with f_{resonant} calculated as

$$f_{\text{resonant}} = 1 / (2\pi \sqrt{L_S C_S}) = 1 / (2\pi \sqrt{L_R C_R}) \quad (5)$$

The maximum VTR are expected at the frequency where the input impedance has the minimum value [6][7].

The mutual inductance, M , between the source and receiver coils can be obtained simply from the slope of the Z_{21} curve of the WPT system, which is represented by the black straight solid line shown in Figure 6b. Using the obtained mutual inductance, M , coupling coefficient, k , can be calculated by

$$k = M / \sqrt{L_S L_R} \quad (6)$$

The resonant peaks over 200 MHz in Figure 6 occur due to the parasitic capacitances of SMA connectors.

Time-Domain

The time-domain measurement is conducted for calculating VTR using the equivalent circuit model depicted previously in Figure 4. In this setup, the terminal voltage, V_s is modeled as a voltage source with the internal source resistance of 50 Ω and the load at receiver side is assumed to be a 50 Ω resistor.

For time-domain simulation, the sinusoidal voltage is supplied as the source at the frequency of 110 MHz, where the input impedance is minimized, and the voltage waveform at the load is detected. And for time-domain measurement, the oscilloscope is used for measuring the waveform at the load, while the sinusoidal voltage with the frequency of 110 MHz is supplied from the signal generator. The voltage waveforms at the load are shown in Figure 7 and it is found that the measurement shows a good correlation with the simulation.

The maximum VTR at the resonant frequency is 0.34; with source voltage of 7 V_{pp}, load voltage becomes 2.4 V_{pp} and the maximum transferred power is expected at the same frequency. In other words, the frequency at which the maximum voltage is transferred coincides with the one where

power transfer efficiency is the maximum, assuming that the source power is same.

As previously mentioned, the coupling coefficient, k , can be simply calculated by Equation 6, where M is obtained from the slope of Z_{21} . To find the relationship between the board-to-board distance and the coupling coefficient, the former is varied from 1 mm to 5 mm in both measurement and simulation. The results are shown in Table 2. The coupling coefficient increases as board-to-board distance decreases; however, load voltage with the fixed frequency of 110 MHz does not have the same trend and it can be observed that its maximum may be around 0.3 of k . This means that k becomes higher in case of decreased distance and hence, tighter magnetic coupling in WPT. In case of tight magnetic coupling, the minimum resonant peak of input impedance (Z_{11}) split into two sides of axis by the resonant frequency of non-tight magnetic coupling case [7]. In other words, higher k does not always guarantee higher VTR at the same frequency. Therefore, it is very important to find the appropriate coupling coefficient in order to maximize VTR at the specific frequency of the source.

ELECTROMAGNETIC INTERFERENCE SHIELDING EFFECT IN WIRELESS POWER TRANSFER BASED ON SIMULATION

In the previous section, VTR of WPT was found to be much smaller than that of wired power transfer. Moreover, low mutual and self-inductances and high resistance of the coil on PCB lead to small VTR, when compared to home-appliance wireless charging systems that adopt coils formed with wires of high self-inductance and low resistance. Therefore, once the receiver fails to capture all of the wirelessly transferred power, the non-transferred power might work as EMI to the other adjacent circuit or interconnection such as metal line and bonding wire. In order to suppress EMI in WPT, the shielding materials like ferrite and metal film are generally used as shown in Figure 8 [8]. Also, self- and mutual inductances can be increased by using ferrite. However, these shielding materials could affect the parasitic resistance of the coil, as well as VTR of WPT. In other words, the shielding materials for EMI suppression cause the side effects that can lower VTR.

In this section, the effects of shielding material in WPT, based on simulation and analysis, are presented.

Equivalent Circuit Model of Spiral Coil with Shielding Material

The new components due to the attached shielding material are added to the equivalent circuit model of spiral coil as shown in Figure 9. The additional self-inductance and the additional parasitic resistance are represented by L_m and

R_m , respectively. Also the additional self-inductance makes additional mutual inductance. The additional capacitance, C_m , is also negligible as the spiral coil and the shielding material are separated by the thickness of the board, which is large enough for the capacitance to be ignored. In this equivalent circuit model, the values of the additional components are varied depending on the type of the shielding material attached, as well as the distance from the board. These results, with more detail, are arranged in Table 3. In case of ferrite film, its complex permeability ($\mu = \mu' - j\mu''$) is $59.7 - j40.4$, which has loss tangent of 0.677 at the resonant

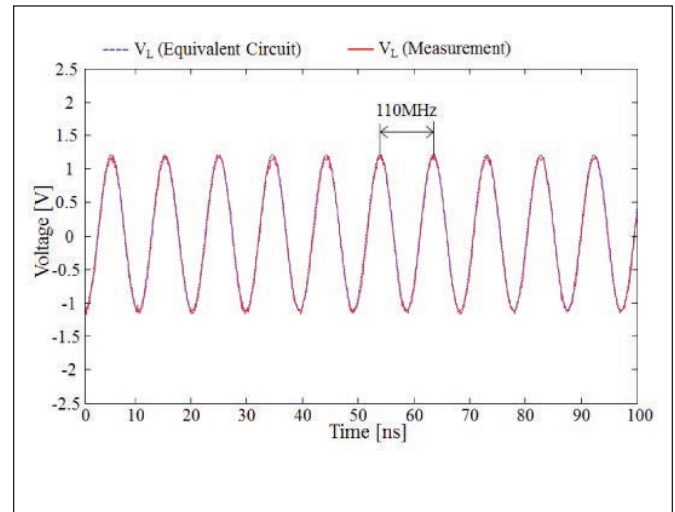


Figure 7: Voltage waveform from measurement and simulation using equivalent circuit model.

Board-to-Board Distance (mm)	Coupling Coefficient, k	Voltage Transfer Ratio
1	0.5	0.42
2	0.32	0.49
3	0.22	0.48
4	0.18	0.42
5	0.13	0.34

Table 2: The performance of coil-to-coil

Shielding Material	Gap Between board and film (mm)	L_m (nH)	R_m (Ω)	Resonant Frequency (MHz)
Ferrite	0.0	115.6	8.9	86.7
Ferrite	0.3	83.6	6.7	92.3
Metal (Al)	0.0	-133.1	1.3	130.7

Table 3: The additional components due to shielding material

It was found that the bigger the gap between the board and ferrite film, the smaller the parasitic resistance, which accordingly results in improved VTR.

frequency of 110 MHz. This ferrite film is a commercial film generally adapted to many applications that utilize several megahertz range for RFID. The large loss tangent causes the large additional resistance and the real part of complex permeability increases the self- and mutual inductance [9]. On the other hand, when metal film is attached to the board, the additional self- and mutual inductance have negative values because of eddy current through metal and therefore, the summation of self- and mutual inductance decreases.

Analysis of Shielding Material Effect in Wireless Power Transfer

VTR of each case from top to bottom in Table 3 is 0.374, 0.383 and 0.005, respectively. Whereas the additional self- and mutual inductance from the ferrite film can improve VTR greatly, the additional resistance degrades it at the same time. Therefore, VTR is increased only a little with the attachment of the shielding material, compared to 0.34, which was the VTR without shielding. In the next case, by attaching the metal film, the negative value of self- and mutual inductance aggravates VTR very much.

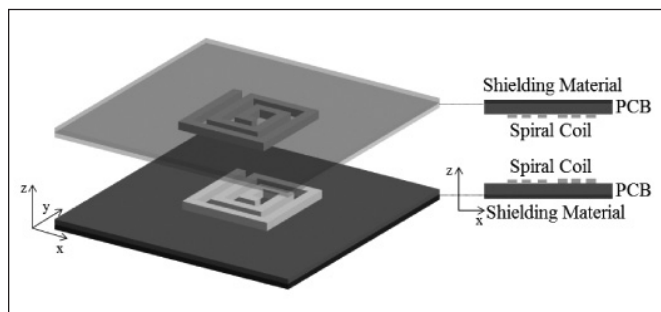


Figure 8: Wireless power transfer for board-to-board level interconnection on printed circuit board with shielding material.

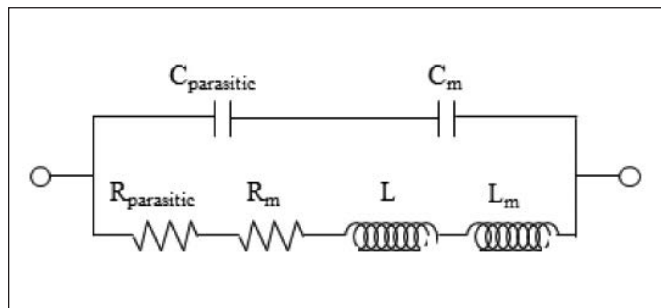


Figure 9: Equivalent circuit model of spiral coil with shielding material.

As can be seen from the 3D EM simulation result in Figure 10, there appears to be a strong magnetic field distribution between the upper source and lower receiver board, which is shown in red. Magnetic field distribution of the source board without shielding material in Figure 10a tends to spread out much more than the other cases. However, ferrite film of source board in Figure 10c and d effectively shields magnetic field distribution regardless of gap between board and ferrite film. Moreover, the metal film in Figure 10b demonstrates much better shielding effect by reducing self- and mutual inductance due to the eddy current. Therefore, magnetic field distribution of each case is a little different depending on the shielding material.

In addition, it was found that the bigger the gap between the board and ferrite film, the smaller the parasitic resistance, which accordingly results in improved VTR. The parasitic resistance is further reduced when ferrite film with low loss tangent at the resonant frequency is attached to the boards.

It should be noted that ferrite film is a better material considering its shielding effect and VTR. To improve VTR for

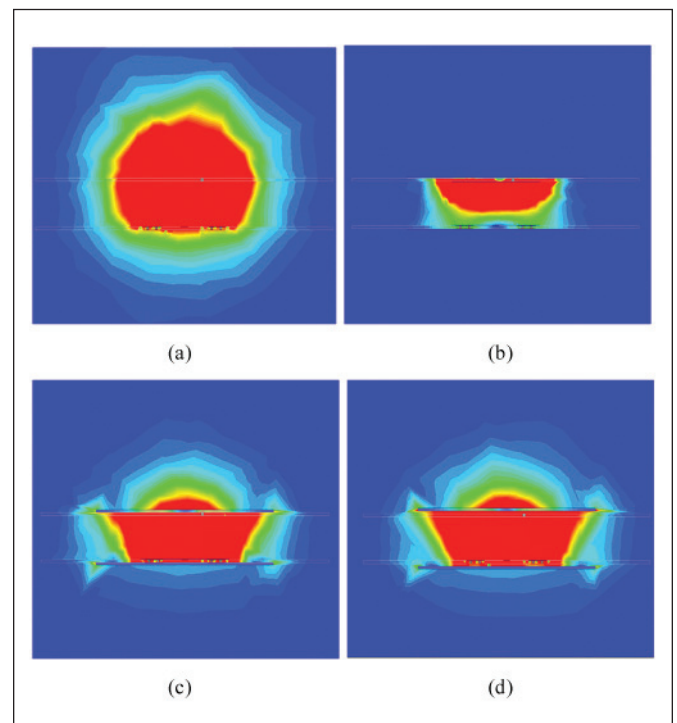



Figure 10: Magnetic field distribution of each case using 3D EM simulation

The performance of WPT can be either improved or degraded depending on the type of shielding material and the gap between the film and board.

board-to-board WPT, changing the gap between the board and ferrite film to control the parasitic resistance is more effective.

CONCLUSION

WPT using magnetic resonance coupling for board-to-board level interconnection is proposed to compare the equivalent circuit model and measurement using impedance curves and VTR. We have modeled the equivalent circuit of the spiral coil using R and L, and have presented the relationship between simulation and measurement in both frequency- and time-domain. Frequency of maximum VTR is predictable from the resonance peak of the input impedance curve (Z_{11}) of WPT. The maximum VTR of board-to-board WPT was achieved to be 0.49, when the distance between the boards was 2 mm, with 0.32 of k. Also, EMI shielding effects in WPT with materials such as ferrite and metal film are analyzed based on simulation. The performance of WPT can be either improved or degraded depending on the type of shielding material and the gap between the film and board. Finally, the shielding effects of each film in WPT were compared by observing magnetic field distribution. Therefore, with further researches to improve VTR and mitigate EMI from magnetic field of WPT, such a system can be widely adapted to applications with board-to-board level interconnection. 

ACKNOWLEDGEMENT

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Sukjin Kim¹, Hongseok Kim, Jonghoon J. Kim, Bumhee Bae, Sunkyu Kong and Joungho Kim are associated with Terahertz Interconnection and Package Laboratory, EE, Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Korea. Comments and questions can be directed to teralab@kaist.ac.kr.

Aeroflex Introduces the 7215 Configurable Automated Test Set

Aeroflex Incorporated announced the release of the 7215 Configurable Automated Test Set. The 7215 is a complete radio test system designed for production and depot-level testing of military and software-defined radios (SDR). The standard 7215 configuration includes a high resolution touch-screen user interface, RF testing up to 2.6 GHz, 90 MHz of instantaneous bandwidth for both digital signal generation and analysis, and multiple RF and audio instruments in a single package. For pricing and delivery information, contact your local Aeroflex sales office or email info-test@aeroflex.com for additional information.

Agilent Technologies Announces Tutorial Videos on Infoline Web Services for Test & Measurement Calibration and Repair Service Records

Agilent has introduced its Infoline web services, an online tool with pre-populated asset list and service records for test and measurement instruments calibrated and repaired by Agilent. The web service features reports, snapshots, and related tools to assist customers to more effectively manage their instruments and coordinate services. Visit www.agilent.com/find/InfolineTutorials for more information.

America Semiconductor Inks Authorized Distribution Agreement with America II

America Semiconductor, LLC, a leading manufacturer of state-of-the-industry high-power semiconductors, and America II Electronics, Inc., one of the world's largest independent

distributors of semiconductors and electronic components have entered into an authorized distribution agreement. Under the terms of the agreement, America II will stock and distribute America Semiconductor's extensive offering of high-power standard, fast and super-fast recovery rectifiers, bridge rectifiers, and low-power semiconductors throughout the US, Europe and Asia, with an emphasis on US markets. For additional information, contact America Semiconductor at 908-810-SEMI(7364) or visit www.americasemi.com

New Low Profile, Quick Release Interconnect From Amphenol Offers High Performance

Amphenol Industrial Global Operations has introduced a low profile, quick release, high power interconnect using Amphenol's new R4 RADSOK technology. The new RADLOK product line provides low insertion and extraction forces with a high mating cycle rating for high power interconnects, making it perfect for frequent mating applications. For more information, visit www.amphenol-industrial.com.

Ansell Expands Touch N Tuff Product Line With Sensitive Neoprene and Polyisoprene Gloves

Ansell announced a variety of new products in the Touch N Tuff product line: the Touch N Tuff 73-500 Sterile Sensitive Neoprene Gloves and Touch N Tuff 73-300 Clean Sensitive Neoprene Gloves for the Life Sciences industry, and the Touch N Tuff 83-300 Polyisoprene Gloves for workers in aseptic and clean environments. These gloves help to reduce the risk of both Type I (latex)

and Type IV (chemical) allergies without diminishing the sensitivity and comfort needed for life science applications. Additionally, the glove's cream color functions as a breach indicator during double-gloved applications when paired with other glove colors. For more information, visit www.touchntuff.com.

API Technologies' New Family of Current Sensors/Transformers Measure a Wide Range of Currents

API Technologies Corp. announced the availability of its new 5300 series of current sensors and transformers that measure a wide range of AC currents by transforming them accurately from high to low measurable values. API's 5300 series current sensors feature a wide primary current range of 3.5 Amps to 800 Amps, and are available in several types of current transformers, including low phase/high accuracy and high frequency. To learn more about the API Technologies' Magnetics product line, please visit eis.apitech.com.

Aries Electronics Announce High-Temp 250° C QFP/QFN Test Sockets

Aries Electronics has announced the introduction of its new 250°C QFP/QFN Test Sockets. The new contact strip sockets are ideal for testing devices in need of high-temp testing as well as "down-hole" devices. Where normal test socket performance made from industry standard BeCu contacts roll-off sharply after 150°C, these new sockets perform up to 250°C. For detailed specifications, visit www.arieselec.com/products/data/24001HT-rf-test-socket.htm.

CONEC's Miniature USB Connectors Provide Advanced Protection for Portable Test and Measurement Equipment

CONEC has developed a series of vibration resistant, bayonet locking USB 2.0 Type-A and Mini-USB 2.0 Type-B Connectors designed for harsh environments, including portable test and measurement equipment. Designed to withstand the effects of torque during repeated mating and un-mating cycles, the rugged interface of the USB 2.0 Type-A and Mini-USB 2.0 Type-B Connectors meet IP67-rating requirements when mated or covered with a protective cap. For more information on USB 2.0 Type-A and Mini-USB 2.0 Type-B connectors, visit www.conec.com or email info@conec.com.

500 Watt High Power Amplifier in 3U Chassis Available Only from Empower RF Systems

Empower RF Systems has introduced the next series of the "size matters" portfolio - 500W in 3U chassis. This new PA family operates in the frequency ranges of 20 - 500 MHz (Model 2173), 500 - 1000 MHz (Model 2174) and 20 - 1000 MHz (Model 2175) with the output power guaranteed over full bandwidth and temperature. Review the "At a Glance" flyer for more information on this new family of amplifiers: www.empowerrf.com/markets/Product_Intro_500Wsystems.pdf.

Popular EMC Antennas from ETS-Lindgren Now Feature Pre-Amplifiers

ETS-Lindgren announced its popular Double-Ridged Waveguide Horn and BiConiLog™ antennas are now

available together with matched pre-amplifiers. Known as Models 3116C-PA and 3117-PA, the antenna and pre-amplifier combination are calibrated as a single unit. This allows for any possible mismatches between the antenna and the pre-amplifier to be taken into account in the antenna factor (AF) which is provided with each unit. To see ETS-Lindgren's complete range of EMC antennas, please visit www.ets-lindgren.com/EMCAntennas.

Hyde IBS Adds Manufacturing Industry Veteran as Regional Sales Manager

Hyde Industrial Blade Solutions (IBS) announced that Steve Foskett has been appointed to the role of Regional Sales Manager. In this role, Foskett will be responsible for managing and training sales representatives in the Eastern United States, expanding the distributor network and providing end-user support. For information on Hyde's products, visit www.hydeblades.com.

High Power, Wide Terminal Flat Chip Resistor Now Available from KOA Speer

KOA Speer Electronics has released a new size for their WK73 wide terminal flat chip resistor series, the 2B (0612) package. The WK732B offers a higher power rating and features high reliability and performance with 0.75W power rating as a result of its enhanced heat dissipation, compared to the standard 0.25W of the thick film 1206 size. The WK732B offers current sensing for power supply circuits, and is ideal for automotive electronics, ECUs, anti-lock braking and air bag systems. For additional information, visit www.koaspeer.com.

Laird Announces New Class 1 Bluetooth® Series

Laird has announced the release of the high performance Class 1 Bluetooth 700 Series modules, which includes both the BT730 and BT740 variant modules. Mass production quantities of modules and the associated development kits are available now from all Laird global distributors. Key application areas for the BT700 Series include medical devices, ePOS terminals, automotive diagnostic equipment, barcode scanners, and industrial cable replacement. For additional information, visit www.lairdtech.com.

Leader Tech Introduces New EMI Microwave Absorber Line Catalog

Leader Tech announces the publication of its first, full-line EA Microwave Absorber catalog. This technical guide features a large selection of narrow and broad band materials for attenuation of frequencies ranging from 500 MHz to greater than 40 GHz. Additionally, custom tuned formulations are available for target frequency problems at no additional cost. The new EA Microwave Absorber catalog can be instantly downloaded from the company's website at www.leadertechinc.com/absorbercatalog.

Monroe Electronics' New Model 300 Charge Plate Analyzer Boasts Rich Functionality, Low Cost

Monroe Electronics announced the release of the Model 300 charge plate analyzer, which offers users an easy, reliable, and cost-effective solution for checking the effectiveness of all ionization-type static control systems and demonstrating charge presence. Offering a robust feature set including on-board data storage, intuitive operation, extended battery life, and a clear, bright LED display, the new

Model 300 simplifies both manual and unattended evaluation of bench-top, room, and overhead ionization systems. Further information is available at www.monroe-electronics.com.

ON Semiconductor's Newest Integrated Slave Transceiver Meets the Challenging Demands of M-BUS Remote Metering Applications

ON Semiconductor has introduced a new integrated slave transceiver for use in two-wire Meter Bus (M-BUS) slave devices and repeaters. The NCN5150 provides all necessary functionality to satisfy the EN 13757-2 and EN 1434-3 standards that describe the physical layer requirements for remote meter reading M-BUS applications in multi-energy, heating and cooling, water and gas meters. For more information, visit www.onsemi.com.

New 4 Channel Digital Oscilloscope with Rigol's Ultravision Technology Designed for the Economic Desktop

Rigol Technologies, Inc. announced the introduction of the DS1000Z Series digital oscilloscope, the latest addition to the Rigol scope family, featuring their UltraVision technology. As another best-in-class testing instrument from Rigol, the new DS1000Z is available in 70 or 100 MHz bandwidths and provides the performance expected from a modern 4 channel oscilloscope, but at the cost of a traditional 2 channel scope. For more information, email Rigol at info@rigol.com.

Schurter Introduces New Power Entry Module Seal Kit

Schurter has announced the addition of seal protection to its successful

5707 series power entry module. A new seal kit provides an IP54 rating between the inlet and cord connector, preventing dust or splashing water from entering between them, when the equipment is plugged in. The unit already carries an IP65 rating, protecting against ingress of dust and jetting water at the panel opening, around the screws and fuseholders, as well as the connector pins and housing. More information on the IP 54 versions of the 5707 and 6100-3 can be found at www.schurterinc.com/New-Products/Connectors.

New Staco UPS for 10 - 40 kVA Applications

Staco Energy Products Company announced the introduction of the FirstLineR PL - a parallelable three-phase Uninterruptible Power Supply (UPS) for 10-40kVA applications. These units boast efficiencies of up to 94% for lower energy costs and reduced carbon footprint, while delivering maximum availability and flexibility. The compact and reliable FirstLineR PL is ideal for information technology (IT) applications such as computer rooms, and network closets, as well as broadcast studios, assembly/manufacturing lines, medical facilities, and other applications where a high level of available power and backup power are essential. For more information, visit www.stacoenergy.com.

TÜV Rheinland Tops List of CB Scheme Certification Providers for Eighth Consecutive Year

TÜV Rheinland is the top certificate issuing body in the CB Scheme for the eighth consecutive year, according to a 2012 report published by the Worldwide System for Conformity Testing and Certification of Electrotechnical Equipment and Components (IECEE). The company placed first in terms of the total

number of product certificates issued: 14,440, representing 19% of all certificates. TÜV Rheinland placed second in the following certification categories: IT and office equipment (OFF), battery (BATT), household and similar appliances (HOUSE), and audio-video (AV). To learn more about CB scheme services, visit www.tuv.com/en/usa/services_usa/product_testing/our_services/cb_scheme/cb_scheme.html.

Vishay Introduces New Precision Thin Film Chip Resistor Laboratory Sample Kits

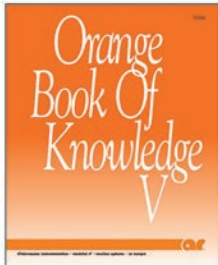
Vishay Intertechnology, Inc. announced that the company is now offering laboratory sample kits of certain precision thin film chip resistors. The MCS 0402 (LCS 96/4) and MCT 0603 (LCT 96/4) kits aid engineers in prototyping and speed time to market in a wide range of electronic systems. The two new Vishay Beyschlag sample kits released today offer roughly 100 of the most popular resistance values in the MCS 0402 and MCT 0603 packages, respectively, with 0.1 % tolerance and temperature coefficient of ± 25 ppm/K. For more information, visit www.vishay.com.

Würth Elektronik opens Electronic Design & Application Center In Munich, Germany

Würth Elektronik eiSos, together with the Würth Electronics Midcom, officially opened the local Design & Application Center in Munich Garching on September 9th. The Design Center offers the engineers from various nations and specialist fields space for ideas to develop new passive and active components and gives sales direct access to customers and IC manufacturers located in the Munich area. For more information, visit www.we-online.com.

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(Authors)

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. Mr. Jonassen passed away in 2006. For Mr. Jonassen's full bio, please see page 17.



MARK STEFFKA is a Lecturer (at the University of Michigan - Dearborn), an Adjunct Professor (at the University of Detroit – Mercy) and an automotive company Electromagnetic Compatibility (EMC) Technical Specialist. For Mark's full bio, please see page 23.



BOB VERMILLION CPP/FELLOW, CERTIFIED ESD & PRODUCT SAFETY ENGINEER-INARTE is a subject matter expert in ESD mitigation of materials and packaging and is an ESDA Standards Committee Member. In 2010, Bob was the first to present on suspect counterfeit ESD packaging in the supply chain at the NASA-QLF. For more about Bob, please visit page 37.



MIKE VIOLETTE is Director and Founder of American Certification Body. He can be reached at mikev@acbcert.com.



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.

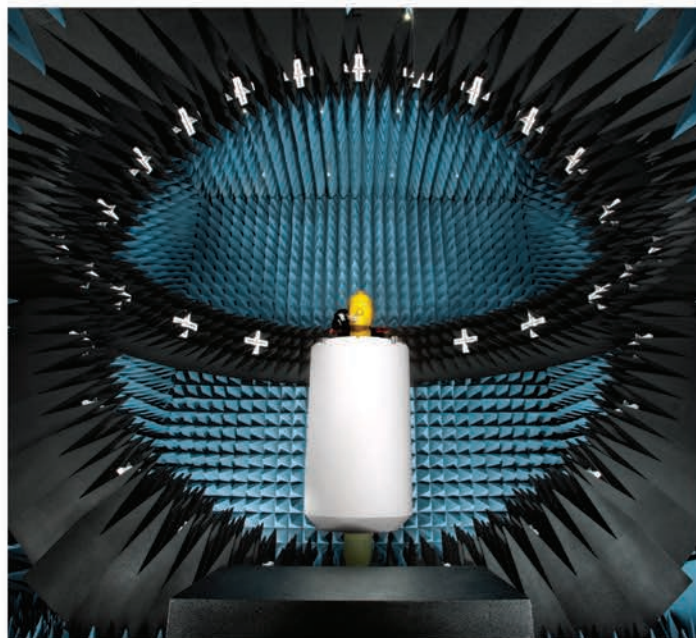
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