



# Chapter Chatter

Todd Robinson, Associate Editor

## Step Voltages

Many thanks to Mike Violette of Washington Laboratories for sharing this wonderful story with readers of the EMC Newsletter.

*One of my father's great passions was the phenomena of lightning. It took him to such exotic locations as Panama, Singapore, Malaysia, South Africa and Charlotte, North Carolina to work on various projects and to teach courses on the subject of lightning protection. We climbed the Statue of Liberty to survey the strike marks on the green patina of the copper lady and surveyed laboratory installations and military sites to protect buildings and equipment.*

*He really loved the stuff and based a lot of his seminar instruction on direct observations and studies and concepts founded on EM fundamentals: anything that dealt with time-changing currents and voltages. It was all Maxwell, baby. Toss in a few Green's functions and you've got yourself some real tools to dig into the physics of EMC. Borrowing from my dad's notebook, this piece shares a quick demonstration of applying electromagnetic models to predict a real-world phenomenon.*

Over the past 20 years the development of standards, such as those based on IEC 1000-4-5 and IEEE C62.41 and related, have promulgated throughout the industry. Equipment—and people—are happier for it.

One of the dangers associated with lightning discharge is something called “Step Voltages” that are developed when currents from a strike to ground dissipate into the surrounding Earth. The currents that flow through the Earth encounter resistance in rocks, soil, snakes, roots and worms and develop I X R potentials. Equilibrium occurs when sufficient combinations of negative and positive charges net out.

I was thumbing through some of my dad's notebooks recently and came across the calculations of this step voltage. The following image (circa 1991) presents the essential model of the event and a calculation of the  $\Delta V$  generated during a discharge. A stroke of current “I” hits the ground and flows out radially in a hemispheric fashion. Here, for the purposes of the calculation, we assume homogenous soil; else the equation would be more difficult than predicting the weather.

$$J = \frac{I}{2\pi R^2} \quad E = \frac{J}{\sigma} = \rho J$$

$$\Delta V = \int_{R_1}^{R_2} E \cdot dR$$

$$\Delta V = \frac{\rho I}{2\pi} \left[ \frac{1}{D} - \frac{1}{D+X} \right] = \frac{\rho I}{2\pi} \left[ \frac{1}{D} - \frac{1}{D+X} \right]$$

$$D = 100 \text{ m} \quad \rho = 100 \text{ } \Omega \cdot \text{m} \quad I = 10^4 \text{ A}$$

$$\Delta V_{100} = \frac{1000 \times 10^4}{2\pi} \left[ \frac{1}{100} - \frac{1}{100+5} \right] = \frac{5 \times 10^7}{\pi} \left[ 0.01 - \frac{1}{105} \right]$$

$$\Delta V_{100} = \frac{5 \times 10^7}{\pi} \left[ 0.01 - \frac{1}{105} \right] = 1.5795 \times 10^6 \left[ 0.01 - \frac{1}{105} \right]$$

$$X = 5 \text{ m} \quad \Delta V_{100} = 14.4 \text{ kV}$$

Whole Page

Lightning develops slowly and discharges wildly. Voltages in the millions develop during the tumult of a thunderstorm to be dissipated in single and multiple strokes that last a few microseconds. The many joules of energy that are expended are the result of energized electrons ripping through an ionized channel in the air, seeking positive ions to combine with and equalize. Currents range from a few kiloamperes to mega-strokes of 100 kA and more. The obvious destructive nature of this natural phenomenon has led from the development of Franklin's Lightning Rod to sophisticated building lightning protection systems and surge suppressor devices.

$$J = \frac{I}{2\pi R^2} \quad E = \frac{J}{\sigma} = \rho J$$

$$\Delta V = \int_{R_1}^{R_2} E \cdot dR$$

Model And Current Density

The basic electric field equation is derived from the current density, “J”, for a hemisphere.

Current density (hemisphere):  

$$J = \frac{I}{2\pi R^2} \quad E = \frac{J}{\sigma} = \rho J$$

Current Density

The voltage developed,  $\Delta V$ , is solved by the well-known integral equation.

$$\Delta V = \int_{R_1}^{R_2} E \cdot dR$$

Deltav

Expanding:

$$\Delta V = \frac{\rho I}{\pi} \left( \frac{1}{R_1} - \frac{1}{R_2} \right) = \frac{\rho I}{\pi} \left[ -\frac{1}{R_1} \right]_{R_1}^{R_2} = \frac{\rho I}{\pi} \left[ \frac{1}{R_1} - \frac{1}{R_2} \right]$$

$$\Delta V = \frac{\rho I}{\pi} \left[ \frac{1}{D} - \frac{1}{D+x} \right] = \frac{\rho I}{\pi} \left[ \frac{x}{D(D+x)} \right]$$

Equation 1

This gives a complete equation for the step voltage,  $\Delta V$ .

Plugging in a few parameters (a large radius of 100 m, resistivity of 1000  $\Omega\text{m}$  and a discharge of 10 kA) gives the following result:

$$D = 100 \text{ m} \quad \rho = 1000 \text{ } \Omega\text{-m} \quad I = 10^4 \text{ A}$$

$$\Delta V_{\text{step}} = \frac{1000 \times 10^4}{\pi} \left[ \frac{1}{100} - \frac{1}{100+x} \right] = \frac{5 \times 10^7}{\pi} \left[ 0.01 - \frac{1}{100+x} \right]$$

$$\Delta V_{\text{step}} = \frac{5 \times 10^7}{\pi} \left[ 0.01 - \frac{1}{100+x} \right] = 1.5915 \times 10^7 \left[ 0.01 - \frac{1}{100+x} \right]$$

Equation 2

The “Step Voltage” that we are interested in is across an incremental distance, “x” within the radius of calculation.

For an “x” of 10 m, the  $\Delta V$  is 14.469 kilo Volts (note the precision of the calculation!). Note, too, that the 10 kA is a nominal number. The end voltage is directly proportional to the current.

$$x = 10 \text{ m}, \Delta V_{\text{step}} = 14.469 \text{ kV}$$

Equation 3

What does this mean? Well, if you are designing a lightning protection system, cabling or a distributed communications system, the “step voltage” through the Earth may drive considerations for dedicated grounding conductors to reduce the effective ground resistance, surge protection, and shielding - that is, all the good EMC stuff.

Lightning, in a sense, is a metaphor for life, for all is transient and we should remember that what we touch, we should also try to illuminate. Certainly my dad believed that.

END NOTE: *It is strange and probably just a coincidence that, as I write this, a lightning storm surges around my house (no kidding). I wonder if someone is looking over my shoulder. I hope I got this right...*

## Chicago

Chapter Secretary Jerry Meyerhoff reports that the Chicago EMC Chapter's November 19, 2008 meeting was hosted at DLS and featured IEEE EMC Society Distinguished Lecturer Dr. Stephan Frei of Dortmund University, Germany. His talk on “Improving ESD Test Reproducibility,” was a real eye-opener for the 39 attendees. Dr. Frei clearly explained how strong variances in outcomes can occur from subtle differences in ESD test devices and setups. Scholarship Committee Chair Bob Hofmann was also pleased to present our second award to Sameer Parikh, an EE graduate student at Northern Illinois University. Our new officers were elected unanimously from the slate proposed by the Chapter's Vice Chair

Roger Swanberg. December 9, 2008 was our 7th Annual Holiday Party at Dave & Buster's. Chapter members and guests enjoyed a relaxing buffet dinner, some spirited billiards-play, the interactive game room and Ray Klouda's *Classic Holiday Trivia Quiz*. Chapter Chair Jack Black kept it all going and awarded great prizes to the raffle and billiards tournament winners. The 2009 season kicked off February 18 at DeVry University's Addison Campus. Roy Leventhal, author and consultant, spoke about “EMC Jobs in the Real World,” a viewpoint quite fitting for National Engineering Week. Roy emphasized that soft or people skills were as critical to success as a keen technical mind. The packed room of 37 people also enjoyed the Chapter-provided

pizza. The Chapter supported National Engineering Week. On February 18, consultant Jerry Meyerhoff spoke on “A Day in the Life of an EMC Engineer” at DeVry University in Addison. On February 21, at the 25th Annual DuPage Engineers Week Expo at the Illinois Institute of Technology, Rice Campus, Jerry reprised Amy Pinchuk's “Radio-Controlled Toy Car in a Soup Pot” EMC shielding demo from the 2004 IEEE International Symposium on EMC in Santa Clara. The young potential engineers and their parents were fascinated. The March 18 meeting was kindly hosted by Underwriters Labs in Northbrook. Programs Co-Chair Andrea Spellman was pleased to introduce her fellow UL colleague, Mike Windler, to the crowd of



Sameer Parikh (left), Graduate Student at NIU, receives the Chicago Chapter's second scholarship award from Treasurer Bob Hofmann in November.



Dr. Stephan Frei makes the point about ESD effects during the November Chicago Chapter meeting at DLS.



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*Jerry Meyerhoff of the Chicago Chapter demonstrates shielding effectiveness at the DuPage Engineers Week Expo held in February.*



*Mike Windler of UL takes questions following his presentation on measurement uncertainty at the Chicago Chapter meeting held at UL in March 2009.*



*Roy Leventhal speaks about "EMC Real-World Jobs" at the Chicago Chapter meeting at DeVry University in February.*



*Andrea Spellman of UL "breaks" at the Chicago Chapter Holiday Party in December.*



*Marianne and Bob Hofmann enjoy dinner while puzzling over the Holiday Trivia Quiz at the Chicago Chapter Party.*



*Dan Glab (left) receives a raffle prize from Jack Black at the Chicago Chapter's meeting at UL.*

37 people. He discussed the topic of "Measurement Uncertainty" and made a lot of statistical mathematics quite clear and applicable! The Chapter is planning several great upcoming programs. These include Chicago Chapter experts Tom Braxton, Bob Hofmann and Roger Swenberg who will give a special, free half day

EMC workshop on April 14 prior to the Magnetics Conference 2009. Next, we will visit ITT on April 22 where we will feature a tech-talk by Chaman Bhardwaj, Publicity Chair, from Shure Brothers. Additionally, we soon will award another scholarship. Chair Bob Hofmann welcomes any contributions. Many thanks to

Maxine Martin of DLS for maintaining our mailing lists, Web Master Frank Krozel for keeping our web presence snappy and Programs Co-Chair Tom Braxton for finding great speakers! May 12 will be our 11th Annual MiniSymposium. Please check for all details at [www.emcchicago.org](http://www.emcchicago.org).



*Chaman Bhardwaj (center) and spouse enjoy a flowering prize delivered by Jack Black at the Chicago Chapter Holiday Party in December.*

## Croatia

Since the last reporting in the Winter 2007 issue, the Croatia Chapter was quite active. Besides the numerous activities in organizing and reporting meetings (10 technical, three social, and one professional), a special Chapter program was dedicated to communications and public relations events. The purpose of these activities was to improve the communication between the members of the EMC and Communications communities interested in exchanging EMC knowledge and the experience. The second half of 2008 was very busy as the most important activities of the Chapter were connected with the organization of the annual Symposium on Environmental Electromagnetic Compatibility. It was the fourth consecutive time that the Symposium has been organized in conjunction with the International Conference on Software, Telecommunications

and Computer Networks – SoftCOM (co-sponsored by the IEEE Communications Society). The conference took place September 25–27, 2008 in Split, on a ship cruising along the Adriatic coast and in Dubrovnik. EMC Society members and the Symposium participants had the opportunity to attend the interesting technical meetings and also enjoy the social events organized in Split, Dubrovnik and on the cruise ship. As a co-organizer of the SoftCOM Conference, the Chapter provides to its members the benefits of direct contacts with the scientists and the professionals from the communications community. So the meetings were helpful not only because the EMC Society members and guests had the opportunity to attend distinguished presentations, but also because they have been useful in improving the cooperation between the researchers from academia and industry from both

the EMC and Communications communities. In this way, the main goal of upgrading the quality and increasing the number of the participants in the technical program was fulfilled by planning the Chapter's activities in conjunction with SoftCOM. The Conference had more than 180 participants from 30 countries with 150 papers accepted for the presentation (about 60% of the submitted papers). The Chapter's members and guests were able to attend presentations of eminent scientists and invited speakers such as *Transhumanism – a Computer Technologist's View*, given by Prof. Gottfried Luderer from the Arizona State University, USA. Excellent presentations at the symposium included, *"Pregnant Woman Exposed to Extremely Low Frequency EM Fields"* given by Dragan Poljak from the University of Split, Croatia as well as presentations by Elya Joffe, *"Understanding EMC, from Garbage of Electronics to Global Intersystem Compatibility,"* *"Who's Afraid of Maxwell's Equations,"* and *"A Practical Approach."* The best student paper competition was organized and one of the Symposium student papers was chosen. An *Ask the EMC Experts* roundtable discussion also took place during the symposium. Discussion continued during the informal meeting which was held on the ship sailing from Split to Dubrovnik. To introduce the benefits of being an IEEE and EMC Society member, the EMC Society promotional booth was displayed twice in 2008. In June, during the Career Day at the University of Split, activities of the IEEE EMC Society and the Chapter were presented primarily to the students in order to encourage them to become IEEE and EMC Society members. In



*Elya Joffe, IEEE EMC Society President, giving the keynote speech during the opening ceremony of the SoftCOM 2008 Conference.*



*Discussion following Dragan Poljak's presentation of the awarded paper "Pregnant Women Exposed to Extremely Low Frequency EM Fields."*





*Informal discussion on EMC topics was held during the meeting organized on the conference ship sailing from Split to Dubrovnik.*



*Algidas Pakstas from the London Metropolitan University presented the problems and the realities of Internet governance on the conference ship.*



*Students were interested in IEEE and EMC Society membership during "Currier Day" at the University of Split.*



*Attendees interested in IEEE and EMC Society membership benefits visited the promotional booth at the EMC Symposium and SoftCOM 2008 Conference.*



*Congratulations to the author of the best student paper, Mario Cvetkovic (left), by Vesna Roje, Nominating Committee and Symposium Chair.*



*Vesna Roje, Croatia Chapter Chair, received the 2008 IEEE Section Award from Sven Loncaric, President of the Croatia Section.*



*A Dubrovnik Middle Age Dukedom performance was organized for the participants of the EMC Symposium and SoftCOM 2008 Conference.*



*A performance of the traditional Dalmatian dance was held during the reception organized in the basement of the Diocletian palace in Split for EMC Society members and participants of the SoftCOM 2008 Conference.*

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September, the promotional booth was used during the Croatia EMC Symposium. The booth was very well attended during this event. The Chapter would like to gratefully recognize the visit of EMC Society Distinguished Lecturer Dr. Franz Schlagenhauer from the University of Western Australia, Perth on 23 June 2008. He gave two outstanding presentations, “EMC Design Principals” and “Computer Simulation on System Level.” Both meetings were accessible by teleconferencing facilities to the members and the guests interested in the subject in four Croatian University Centers (Split, Zagreb, Osijek and Rijeka). The year 2008 was very successful for the Croatia EMC community. We are thrilled that the Chapter has been honored with the IEEE EMC Society 2008 Chapter of the Year Award. Additionally, Chapter founder and current Chair, Vesna Roje, has been recognized by the Croatia Section for her outstanding contribution and leadership.

## Dallas

The February meeting of the Dallas EMC Chapter was held on February 17, 2009 at the Holiday Inn Select in Richardson. Twenty eight attendees were present for the meeting where they viewed Bruce Archambeault’s “DL on DVD Series” presentation of “Effective Power/Ground Plane Decoupling for PCBs.” Current Chairman Joe Stanfield gave recognition to past chairman Carl Irby with an award for his leadership as the Dallas EMC Chapter Chairman in 2008. The next monthly meeting was held on March 17, 2009 at the NEMKO USA facility in Lewisville, Texas. The technical program was presented by Tom Tidwell, Telecom Direct Specialist for NEMKO. Mr. Tidwell helpfully covered the topic of modulation techniques for communications. In his presentation, he described the entire major and many minor RF modulation methods used in the communications industry today.

## Hong Kong

The Hong Kong EMC Chapter held a successful technical seminar on February 6, 2009. An excellent presentation was given by Dr. Peter S. W. Leung, Associate Professor of Electronic Engineering at the City University of Hong Kong, on the topic “Recent Studies in Human Safety Due to RFI.” A total of 39 participants, plus 11 IEEE members, attended the seminar. On March 6, the Hong Kong Chapter hosted a successful a course on the topic of “Electromagnetic Compatibility (EMC) – From Fundamentals to Standards, Measurements and Design.” This talk was also presented by Dr. Peter S. W. Leung. A total of 17 participants attended the course.

## Huntsville

The Huntsville EMC Chapter has started off on another great year. We’ve already had two technical meetings in January and February, and have five more meetings planned for the year. The year



*The 28 attendees at the February Dallas EMC Chapter meeting enjoyed refreshments at the Holiday Inn Select in Richardson prior to the meeting.*



*Attendees at the February Dallas Chapter meeting viewed Bruce Archambeault’s “DL on DVD Series” presentation of “Effective Power/Ground Plane Decoupling for PCBs.”*



*Tom Tidwell presenting “RF Modulation Methods” to the Dallas Chapter in March.*



*Joe Stanfield (left), Dallas EMC Chapter Chair, presenting March speaker Tom Tidwell with a thank you certificate.*





*Members of the Dallas Chapter of the IEEE EMC Society enjoyed pizza before the March meeting.*



*Joe Stanfield (left) presented Carl Irby with an award for being the Dallas EMC Chapter Chairman in 2008.*



*The technical presentation at City University in Hong Kong on "Recent Studies in Human Safety Due to RFI" was presented by Dr. Peter S. W. Leung.*

started off with our January 15 meeting held at ADTRAN. There were a total of 53 attendees who came to hear the technical session by Paul Stover and enjoy the meal provided Wyle Laboratories (Mr. Jack McFadden). Paul presented "Electrostatic Discharge – The Phenomena, Testing and Design Guidance for Improved Immunity Performance." The presentation covered everything from a basic description of the ESD phenomena to very useful tips for repeatable testing as well design tips to make products immune to ESD. The presentation provided for a lively discussion with the local audience. The next meeting was held at PWG Systems on February 21. We had another great turnout of 41 attendees. HV Technologies provided



*Fifty participants attended the technical seminar presented by Dr. Peter S. W. Leung to the Hong Kong EMC Chapter.*

the presentation as well as the meal for the meeting. The presentation by Nick Wright was entitled "Voltage Spikes on Aircraft Power Interfaces." The presentation covered both the RTCA and Euro-

pean based test methods. Nick provided interesting technical bits about the history of the interference and how the tests were developed. The presentation discussed how voltage spikes are present, to some degree, on all system power interfaces. Electronics fitted to aircraft need to be tested to ensure their immunity to switching transients. Many standards are in existence which propose divergent impulse and test techniques. There was discussion of the current challenges in the approval of the Boeing 787 and Airbus A350XWB aircraft families. The presentation was well received and Nick did a great job of answering the questions from the audience. Our next meeting on April 16 will be held in conjunction with a two-day



*Rob Lambdin and Skip Grierson of ADTRAN (front row seated) engage in conversation over dinner during the January EMC Huntsville Chapter meeting.*



*Many thanks go to Nick Wright (speaker), Don Brown, and Tom Revesz (from left) of HV Technologies for sponsoring the February EMC Huntsville Chapter meeting.*

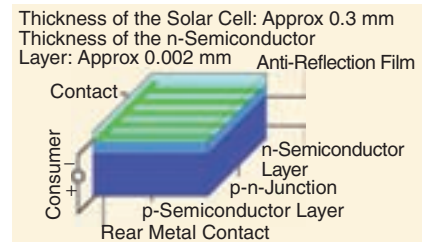
class presented by Henry Ott of Henry Ott Consultants. Henry Ott graciously offered to speak to our Chapter while he was in town. The two-day class is already SOLD-OUT!!! The IEEE EMC Society Board of Directors will be holding a three day meeting series in Huntsville on November 12–14. While in town they have also offered to sponsor a local Chapter meeting and provide a speaker for the talk. To see everything going on with the Huntsville Chapter, check out our website at <http://ewh.ieee.org/r3/huntsville/emc/>

### Northern Virginia/ Washington DC

Mike Violette, Acting(-up) Chapter Chair, reports that members and guests of the Washington DC Northern Virginia EMC Society Chapter recently paid a visit to the world-class BP Solar plant in bucolic Frederick, Maryland. On a chilly day, bathed in the bright shine from old Sol, the group of 22 convened for a three hour presentation/tour of one of the largest cell fabrications on the planet. BP Solar's plant is an iconic structure with the south-facing roof covered with solar

panels. Dr. Jean Posbic, Project Director of BP Solar and a solar power enthusiast, gave a one hour overview of the history of solar generation, starting with Dr. Albert Einstein's explanation of the photo-electric effect (for which he won the Nobel Prize – not that *other* theory that he is so strongly associated with). The PE effect, while interesting to those studying waves and particles and how quantum mechanics vibrate under the fundamental structure of the universe, explains how sunshine makes juice; and we're not talking Florida navel. Pure silicon, as the good Doctor (Posbic) points out, doped with boron and phosphorous, creates a material with a funny affinity to photons. Basically, a solar cell is a big diode. When the right wavelength (energy) of light hits the stuff, it displaces loose electrons in the matrix, overcoming obstacles like "band gaps" and dispatching with the onerous "work function". The little "e's" migrate to the collector conductors lying on top of the stuff. The "P" layer is bonded to an aluminum backing plate and the voltage generated between the plate and the contacts on the "N" layer create the electricity. Current technology uses an ultra pure form of silicon, the

most abundant element in the Earth (think white sandy beaches or the Sahara), which arrives at BP Solar in 500 pound ingots or "bricks". The bricks are slowly sawn into wafers and processed in a diffusion oven, doped into thinking it is a semiconductor. The collectors are screen printed with a silver paste, made much in the same way as the "I'm With Stupid" T-shirt you bought from the boardwalk kiosk on your last trip to Atlantic City. Copper conductors are then soldered to the individual cells and modules are made up to form panels. A durable anti-reflection



*Pure silicon, as the good Doctor (Posbic) pointed out, doped with boron and phosphorous, creates a material with a funny affinity to photons. Basically, a solar cell is a big diode, as can be seen above. (Photo: [www.solarserver.de](http://www.solarserver.de))*



*Paul Stover of ADTRAN spoke at the January EMC Huntsville Chapter meeting on "ESD Design Guidelines."*



*Northern Virginia/Washington DC Chapter members pose for a group photo following an excellent meeting at BP Solar.*





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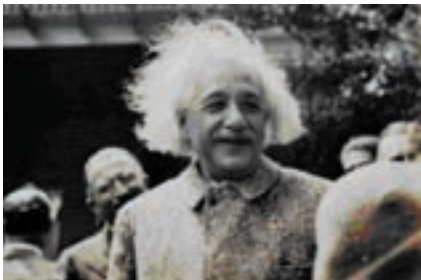
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*The BP Solar manufacturing facility that was toured by the Northern Virginia/Washington DC Chapter.*



*Dr. Jean Posbic, Project Director of BP, provided a helpful presentation to the Northern Virginia/Washington DC Chapter on solar cell history, technology and production.*



*Dr. Jean Posbic, Project Director of BP Solar, and a solar power enthusiast, gave a one hour overview of the history of solar generation, starting with Dr. Albert Einstein's explanation of the photo-electric effect (for which he won the Nobel Prize – not that other theory that he is so strongly associated with).*

are assembled and distributed into those markets. Something like 120,000 cells per month are manufactured at this one location (one of the world's largest). Some of the more interesting applications, now that Green is In and Green is Good, are grid-tied systems for residential use, all the way up to cooperative ventures in Germany and other places where residents will pool their money and develop large roof-top systems which create credits and gives everyone a good feeling when their lagers are cooling in the fridge. Wait, they drink their beer warm. Never mind. Solar cell efficiencies from monocrystalline silicon (like the cells manufactured by BP Solar) run about 15%. The limiting factor is the narrow band of photon energies that the structure is "tuned" to. Much of the light falling on the cell either does not have the energy sufficient to bump the electrons from their orbits, or has too-high energy and the quantum states that are sympathetic to that energy don't exist in the structure. It all just becomes entropy in the end for those rejected quanta. Small gains in process purity and manufacturing may bump the efficiencies towards

20%, but not much more than that. Our dispositions were raised to positively sunny by the tour and hospitality, as we posed for a group shot in front of the entrance.

### **Oregon and SW Washington**

Dave Britton, Chapter Chair, reports that the Chapter experimented with a DVD presentation from Dr. Howard Johnson for the February meeting. There were two each 30 minute videos. After each video, a short panel discussion was facilitated to discuss practical applications of the information received. In March, Senior EMC Engineer, Dave Arnett of Hewlett Packard discussed "Orthogonal Frequency Division Multiplexing (OFDM)" to a well attended meeting. OFDM has become an ubiquitous communications scheme used in many everyday devices. The Chapter is sponsoring a full day colloquium on April 13 with Dr. Eric Bogatin. It will be focused on the topic of signal integrity and held at the University of Portland. The University has provided the Chapter with terrific meeting rooms for several years. All full

film is laminated on top of the collection of modules, fitted with electrical connectors and mounted into an aluminum frame. BP Solar acquired Solarex, which has been making solar cells for the past 35 years, beginning as a spinoff of COM-SAT; the first solar cells flew on satellites starting in 1958. BP Solar runs 24/7 and ships semi-finished cells to factories in Europe and China, where the final panels



*A nearly full house enjoyed the presentation at the Oregon-SW Washington meeting in February.*



*Speaker Dave Arnett explained the intricacies of OFDM to the Oregon-SW Washington Chapter.*



time university students will be admitted to the event at no cost. In May, our speaker will be Dr. Scholz from LeCroy. We are busy putting together our summer social and fall schedule of speakers.

## Phoenix

Harry Gaul reports that the first meeting in 2009 of the Phoenix EMC Chapter featured Dr. Eric Bogatin who spoke about "Ten Habits of Highly Successful Designers." Eric is a Distinguished Lecturer for the EMC Society and he is a signal integrity evangelist for Bogatin Enterprises, which specializes in signal integrity training and education. A total of 29 people attended this presentation. Eric stressed the importance of watching out for six problem areas for signal integrity including reflections, crosstalk, ground bounce, dielectric losses, voltage droop and EMI. The root causes should be first identified and then design guidelines (habits) should be established to minimize the problems. Some of the

habits include designing all interconnects as controlled impedance, using multiple ground and power planes on adjacent layers, using as many decoupling caps as you can place on the board, and not crossing gaps in return planes with signal traces. A wealth of information including this talk is available on Eric's web site at <http://www.bethesignal.com>. The Chapter's second meeting in 2009 featured Dr. Bruce Archambeault who spoke on "The Ground Myth." Bruce is an IBM Distinguished Engineer at IBM in Research Triangle Park, North Carolina. This meeting was held in conjunction with one of the EMC Society's quarterly Board of Directors meetings. A total of 65 people attended this presentation. Bruce started his talk with a little history about Scotland. He noted that Maxwell was the greatest contribution from Scotland after Scotch. Bruce emphasized the point about the return current will always find the path of least impedance back to its source. As EMC engineers, it's either up to us to

control that path or it will be up to God and Maxwell to figure it out. The bottom line is "How lucky do we feel today about the current getting back to its source?" Bruce provided some interesting insight to so-called differential signal traces. First, these traces actually have significant current flow into and out of the signal reference planes because of the close proximity between the pair traces and the planes. Thus, careful consideration must be used when routing these traces above reference planes to ensure the traces do not encounter discontinuities in the planes such as gaps. Also, unequal trace lengths of the differential traces will create timing skew that may minimally affect signal quality but will create large common mode currents, which are responsible for most EMC problems. Bruce's presentation slides are available for downloading at the Phoenix EMC Chapter Web site at <http://www.ewh.ieee.org/r6/phoenix/phoenixemc/>. Check out the site for information on future Phoenix meetings as well.

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*Harry Gaul (left) presents Dr. Eric Bogatin of Bogatin Enterprises with an Arizona Highways calendar as thanks for his excellent talk on signal integrity to the Phoenix Chapter.*



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*EMC Society President Elya Joffe (left) chats with Allen Fenske of Honeywell at the happy hour preceding the Phoenix Chapter meeting.*

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*Attendees at the Phoenix meeting include (from left) Lo-An Gaul with Harry Gaul, Jim Dykema and Steve Gerard of General Dynamics, and Qing Zhou of Intel.*



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*There was a great turnout of 65 Phoenix EMC Chapter members and guests at the March meeting held at the Hilton hotel.*

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*Bill Blandford (left) of Orbital Sciences talks with EMC Society Board Member Henry Benitez.*



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*Catching up at the Phoenix meeting were (from left) Joe Chott of General Dynamics, Ron Longmoor (retired), Mike Stimbart of General Dynamics, and Neal Fousbee of Honeywell. Neal drove up from Tucson to visit old friends at the Phoenix Chapter.*

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*The EMC Society Board of Directors joined the Phoenix EMC Chapter for dinner prior to the meeting.*



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*Dr. Bruce Archambeault of IBM presented the popular lecture titled "The Ground Myth" at the Phoenix EMC Chapter meeting on March 21.*



## Santa Clara Valley

Jerry Ramie reports that Steve Weir of Teraspeed Consulting Group spoke at their January 13 Chapter meeting.



*Steve Weir of Teraspeed Consulting during his presentation to the Santa Clara Valley Chapter in January.*

Mr. Weir's topic was "GSM Handset Noise: Coping with the Buzz of Death." According to Steve, GSM telephones are notorious for inducing a disturbing 217Hz buzz in almost any electronics that includes an audio output. The problem is severe enough that many GSM handsets emit audible buzz as victims of their own RF interference. His talk provided a brief and helpful overview of the reasons behind the GSM "Buzz of Death" and the suppression techniques available to cope with the problem. Steve is an independent consultant with over 20 years of industry experience and a broad range of expertise. Steve holds 17 US patents and is a consultant with Teraspeed and to X2Y Attenuators. Steve has been the architect of a number of TDM and packet based switching products, consults on patents and is a frequent contributor to the SI-list signal integrity reflector.

## Seattle

Dennis Lewis, Chair of the Seattle EMC Chapter, invited colleague Frank Whetten of The Boeing Company to speak at the Chapter's first meeting of 2009. Held the

afternoon of March 24 at T-Mobile in Bellevue, Dr. Whetten gave a presentation titled "Radar Interference and Airborne RLANs." Some 25 Chapter members and guests attended the meeting that was graciously hosted by T-Mobile. Following a wonderful buffet lunch compliments of Agilent Technologies, the meeting began with a student presentation by Tim Ogne titled, "A Pedal Powered Generator for Rural Africa." Tim described how rural Africa lacks a readily available source of electricity. This affects many aspects of daily life: communication, education, and safety. With a group of students at Seattle Pacific University, they developed a pedal powered generator to provide an inexpensive, renewable source of energy for personal use. The key features of this device are the ability to charge an internal or external battery and use the internal battery to power a variety of devices through both a 12 Volt DC output and a 230 Volt AC output. He explained how many people in rural Africa have cell phones, but not easy access to power to recharge the cell phones. By building on the weaknesses of other available products, he showed how this simple device could



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*Seattle Chapter Chair Dennis Lewis (far left) of Boeing joins Steve McCoy and Sarah Ditlevson of Agilent Technologies, the generous lunch sponsors for the March Chapter meeting.*



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*Kitty Tam of Microsoft and George Stults of WatchGuard Technologies Inc. attended the March meeting of the Seattle EMC Chapter.*



© DENNIS LEWIS

*Speaker Frank Whetten of Boeing visited with Seattle Chapter Vice-Chair Janet O'Neil of ETS-Lindgren following his presentation at the March meeting.*



© JANET O'NEIL

*Seattle Chapter Secretary Pat André of André Consulting shows a souvenir from the 1991 IEEE Symposium on EMC in Cherry Hill, New Jersey.*

make a significant impact in rural Africa. Following the informative student presentation, Dr. Whetten gave his presentation. He described a study made of the efficacy of Dynamic Frequency Selection (DFS) in avoiding C-Band radar interference due to airborne Radio Local Area Networks (RLANs). IEEE 802.11a/n RLANs operating in the 5GHz band have the potential to interfere with numerous radar systems, which operate on the same frequencies. He summarized a report that outlines the issues surrounding airborne use of 5GHz RLANs, the testing performed, and the conclusions obtained. It was a most interesting presentation from Dr. Whetten, who received his Ph.D. in antennas and electromagnetic field theory from Arizona State University in 1993. Over the course of a 25-year engineering career, he has designed and built antennas and antenna systems, computers, analog and digital systems, and computer networks. He was tenured as Associate Professor of Electrical Engineering at Embry Riddle University when he joined The Boeing Company to architect airborne

wireless networks in 2003. Today he is an Associate Technical Fellow in the Cabin and Networks Technical Center. The Seattle EMC Chapter appreciated this presentation by a local expert as well as the support provided by T-Mobile for the use of their wonderful meeting facility and Agilent Technologies for the great buffet lunch. Thanks go to Dean Shipman of Syntek, the Seattle EMC Chapter's "logistics point man", for coordinating the meeting arrangements with Fermin Romero of T-Mobile and the lunch with Steve McCoy of Agilent Technologies. The Chapter looks forward to its June 5 meeting with Dr. Bruce Archambeault of IBM in North Carolina. Dr. Archambeault will present a half day seminar titled "Incorporating Affordable EMI/EMC Software Tools into the Real-World Design Process." This will be held on the Microsoft campus in Redmond. For details on this meeting and others, check out the Seattle EMC Chapter activity on the IEEE Seattle Section website [www.ieee-seattle.org](http://www.ieee-seattle.org). All are welcome to attend the Seattle EMC Chapter meetings!

## Taipei

The 2008 International Workshop on Electromagnetic Compatibility (EMC) was held on October 10, 2008 at the Taipei World Trade Center (TWTC) Nangang Exhibition Hall, Taipei, Taiwan. The workshop chaired by Professor Tzong-Lin Wu (NTU, Taiwan) was sponsored by the IEEE Taipei Section, IEEE Taipei EMC Chapter, and IEICE Taipei Section. The objective of this workshop was to accelerate the momentum of research in the area of EMC and provide a knowledge sharing platform for researchers from the Asia-Pacific region as well as other parts of the world. The participants came both from academia and industry in Taiwan. The number of attendees reached 108 with 59% from academia and 41% from industry, which marks a great success in bringing academia and industry together. Three international scholars and seven experts from Taiwan were invited to give speeches. These three scholars were Professor Todd Hubing (Clemson University, USA), Professor Hiroshi Inoue (Akita





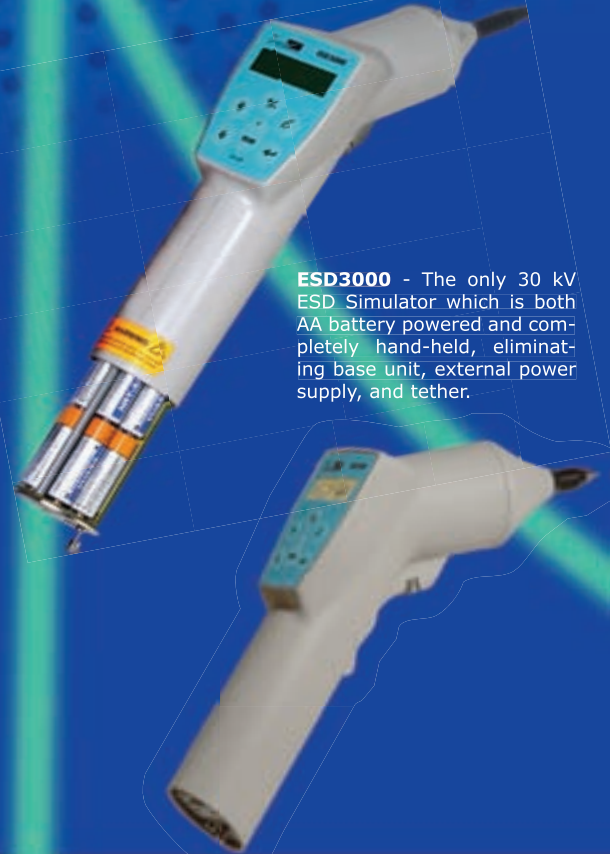
*The best workshop held at the best time with the best organizers, including (from left), Professor Tzong-Lin Wu (Chairman of the workshop) and Professor Ruey-Beei Wu (Chairman of the IEEE Taipei Section).*

University, Japan), and Dr. Er-Ping Li (IHPC, Singapore). Their presentation topics included "Modeling the Maximum Radiated Emission from Printed Circuit Boards," "Basic Study on Undesired EM Radiation and Suppression," and "Modeling of Electrical Package Signal Integrity and Power Integrity," respectively. Dr. Er-Ping Li's talk represented Distinguished Lecture activity on behalf of the IEEE EMC Society. In addition, seven experts in Taiwan also provided excellent presentations about signal integrity issues of PCBs by Dr. Shou-Kuo Hsu (Foxconn Corp.) and Professor Chi-Wen Kuo, ESD issues and circuit protection by Professor Ming-Dou Ker (NCTU), EMI issues at power frequencies by Professor Chang-Fa Yang (NTUST), electromagnetic bandgap structure design by Professor Ray-Beam Huang (NCTU), and EMI/RFI issues in wireless communication products by Professor Han-Nian Lin (FCU) and Dr. Daniel Lee (Sporten Inc.) The workshop was highly interactive with many questions and comments among the participants and the speakers. The participants greatly appreciated this one-day workshop dedicated to EMC because it was an inspiring and insightful experience with both technical depth and breadth. The chairman, Professor Tzong-Lin Wu, on behalf of the organizing committee, would like to thank all the attendees, especially Professor Ruey-Beei Wu (chairman of the IEEE Taipei Section) and Professor Song-Tsuen Peng (chairman of the Taipei EMC Chapter) for their kind support in every aspect, which made the workshop a wonderful and fruitful experience.

### Twin Cities

The Twin Cities Chapter's final meeting for 2008 was a joint meeting with the Twin Cities Chapter of the IEEE Reliability Society. The meeting was held on November 18, a couple of weeks before winter weather settled into Minnesota, at the always popular Mermaid Event Center in Mounds View, Minnesota. The meeting began with a social hour where EMC Society members were able to catch up with each other after the busy but all-too-short summer season and make new best friends with members of the Reliability Society. Following dinner, John Kappenman, from the Applied Power Division of Metatech Corporation, gave a riveting presentation titled "Electric Power Grid Vulnerability to Geomagnetic Storms." John's talk explored the threat assessment efforts underway in

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*The invited speakers and organizing committee members of the 2008 International Workshop on EMC pose for a group photo after the workshop. From left in first row, Professor H. N. Lin, Dr. Er-Ping Li, Professor Song-Tsuen Peng (chairman of the Taipei EMC Chapter), Professor Ruey-Beei Wu (chairman of the IEEE Taipei Section), Professor Hiroshi Inoue, Professor Todd Hubing, Professor Tzong-Lin Wu (chairman of the workshop), and Dr. Shou-Kuo Hsu.*

the USA to provide a broad perspective on the interactions of geomagnetic storms with electric power grids and infrastructure. Space Weather and the resulting geomagnetic storms associated with ejection of charged particles from the Sun produce significant disturbances in the normally quiescent geomagnetic

field at the Earth's surface when they collide with the Earth's magnetosphere. These disturbances have caused catastrophic impacts to technology systems in the past (e.g., the power blackout in Quebec in March 1989). More importantly, as detailed examinations have been undertaken concerning the interac-

tion of geomagnetic storm environments with power grids and similar infrastructures, the realization has developed that these infrastructures are becoming more vulnerable to disruption from electromagnetic interactions for a wide variety of reasons. Both Chapters are appreciative of Mr. Kappenamn's efforts to join us for this meeting. In the spirit of John's presentation, the Twin Cities EMC Chapter presented him with a flashlight that will always function in the event of a power failure, as it does not need batteries or rely on power from the grid to operate. Chapter officers met on February 10, 2009 to plan the Chapter's activities for the upcoming year. A slate of exciting events and meetings throughout the year are planned. At this meeting, new officers were elected. Brodie Pedersen is the new Chapter Chair. John Maas is now Vice-chair. Dan Hoolihan continues as Treasurer and Program Chair, and Tim O'Shea has been elected to serve as Secretary. The Twin Cities Chapter expresses its sincere gratitude to Joel Peltier for his many years of dedicated service to the Chapter, serving most recently as Chapter Chair. EMC



*The Taipei Chapter's successful workshop attracted 108 attendances. All eyes and ears are glued to the speakers during their presentations.*



*John Kappenman of Metatech Corp., Bob Schlentz (retired), and Joel Peltier (from left) of Medtronic are shown at the Twin Cities November 2008 meeting.*



*Pictured at the November 2008 Twin Cities meeting are, from left, Jim McLinn, Consultant, Larry Akre of Sauer-Danfoss, Erik Borgstrom of Environ, Terry Cureton Consultant, Cbris Strand of Unisys, and Dan Selness of Stratasyss, enjoying dinner prior to Mr. Kappenman's presentation.*



*Dan Hoolihan (left) of the Twin Cities Chapter presented John Kappenman with a flashlight that never needs winding or batteries and will work just fine in the event of a grid outage caused by a geomagnetic storm.*