



THRESHOLD™

The ESD Association newsletter, published for everyone with an interest in the understanding and control of electrostatic discharge.

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May/June 2011

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*Symposium Program
Now Available!*



Visit the Association web site www.esda.org to download your 2011 Symposium program and registration guide.

ESD DEVICE DESIGN ESSENTIALS

JUNE 13-14, 2011

Sheraton Mission Valley San Diego Hotel,
San Diego, CA

Instructors: Gianluca Boselli, Texas Instruments;
Michael G. Khazhinsky, Silicon Labs



This two-day seminar consists of concentrated versions of twelve ESDA tutorials which comprise the ESDA Device Design Certification Program.

- ESD On-Chip Protection in Advanced Technologies
- SPICE-Based ESD Protection Design Utilizing Diodes and Active MOSFET Rail Clamp Circuits
- EOS/ESD Failure Models and Mechanisms
- On-Chip ESD Protection in RF Technologies
- Charged Device Model Phenomena and Design
- Latch-up Physics and Design
- Circuit Modeling and Simulation for On-Chip Protection
- Troubleshooting On-Chip ESD Failures
- Device Testing—IC Component Level: HBM, CDM, MM, and TLP
- Impact of Technology Scaling on ESD High Current Phenomena and Implications for Robust ESD Design
- Transmission Line Pulse Measurements: Parametric Analyzer for ESD On-Chip Protection
- System Level ESD/EMI: Testing to IEC and other Standards

DAY 1 JUNE 13

PART I (8:00 AM-Noon)

This part reviews the fundamentals of ESD testing, high-current physics, and ESD modeling. The focus is on device-level (HBM, CDM, MM, TLP) and system level testing, impact of technology scaling on ESD high current phenomena, as well as, circuit modeling and simulation for on-chip protection.

PART II (1:00 PM-5:00)

The principles from part I are then applied to ESD Protection Design. Part II describes ESD on-chip protection in advanced technologies, SPICE-based ESD protection design utilizing diodes and active MOSFET rail clamp circuits, etc.

DAY 2 JUNE 14

PART III (8:00 AM-Noon)

This part describes special ESD design cases, including Charged Device Model (CDM) phenomena and design and on-chip ESD protection in RF Technologies.

PART IV (1:00 PM-5:00)

The final section discusses latch-up, EOS/ESD failure models and mechanisms. The seminar concludes with practical examples for troubleshooting of on-chip ESD failures.

From the President

Inside ESDA....



Donn G. Bellmore

Hello everyone. In the last issue of Threshold I eluded that spring was around the corner. Here in the North Eastern Part of the US, plants and flowers are finally starting to come up and robins have been spotted singing their happy songs of the season.

A short while back, I was looking for some information in one of the archived issues of Threshold when I came across an interesting letter in the March-April 2007 issue.

The letter, by past-president Kay Adams, discussed the importance of the standards meeting series. Here is an excerpt from that letter that I would like to share with you.

“How do I measure this success? My first metric is attendance - there were nearly 100 people in Anaheim who had the support of their employers, and volunteered their time to participate in these important activities. One volunteer flew across the country to attend a one-hour meeting and contribute his input to the success of an important

activity. I know of three individuals who expressed an interest to become more involved with our organization!”

Over the last few years the Association has been very busy with standards and education. If we look at recent attendance (which has dropped a small amount due to the economy and the increased cost of traveling) we continue to be very successful. The attendance indicates that ESDA is engaged in important work for the industry we serve. Many of the volunteers attending the standards meetings series have also become involved in other facets of the Association, such as the Symposium steering committee, human resources, education, or marketing & communications. New volunteers who have an interest in personal growth through involvement with ESDA are invited to sit in on the meetings. A meeting schedule showing the dates, topics, and times of the various meetings are posted on the website (www.esda.org) – anyone who is interested is welcome to attend. New volunteers and the many volunteers whose efforts make this organization successful are very important. We thank you.

Hey did you know?

The ESDA is revamping our website to improve navigation and information. If you have not visited the site recently, please do. I think you will find a pleasant surprise. Links and buttons have been cleaned up and moved around to make finding information easier. The “ESD” page has additional

ESD resources including publications by other ESD and standards organizations. It also has the newly updated six-part “ESD Fundamentals” which is a very handy and clearly written resource. The “Standards” page has also been updated to make finding and ordering the documents you need easier and more efficient. Be sure to check out the “Standard Committee” link if you are interested in volunteering for one of the working groups. The “Education” page has up-to-date courses and training programs along with information on archived online tutorials, on-campus activities, and ESDA professional certification. In the “For Members” section, technical reports are available for download, as well as the current year’s Symposium proceedings and the membership roster. If you can’t find what you are looking for you can search within the ESDA website with the search box located on the home page. I have to admit that I was pretty impressed with this function. I am not a computer whiz so it really makes finding things on the website more convenient. As I said, if you have not visited the site, please do; and if you have visited the site recently, check back soon as it is still changing and evolving.

I hope everyone is enjoying spring. As we start our spring and summer travels I wish you a fun and safe season.

Donn G. Bellmore

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2012 Board of Directors Nominations

ESD Association Members Can Cast Votes Before July 1, 2011

Nominations are placed and ESD Association members have been sent a link to this year's **online voting system**. Select up to four nominees to serve on the ESD Association Board of Directors for the three-year term beginning January 1, 2012. Members may cast "write-in" votes by typing the name(s) of a person(s) in the "write-in" box.

The following individuals are seeking a seat on the Board of Directors for the next term:

Kevin Duncan

Kevin is a senior staff engineer in the Advanced Assembly Development Engineering department of Seagate Technology in Bloomington, MN, where he has been the Site ESD Coordinator since 2005. He is responsible for controlling factory level ESD in the ultra sensitive slider and head gimbal assembly (HGA) processes.

Kevin has been a member of the ESD Association since 2000 and is currently a member of the Standards Committee, Technical and Administrative Support (TAS) Committee, and Technical Program Committee. He serves as the working group chairman for WG 3 – Ionization and participates in several other working groups.

Kevin is a technical expert of the United States National Committee,



where he represents the United States participating in International Electrotechnical Commission (IEC) Technical Committee 101 – Electrostatics and he currently serves as Convener of Maintenance Team 9 - Flooring. He is an ESD certified professional program manager and an INARTE certified ESD engineer.

Kevin graduated in 1998 from the University of Wisconsin – Stout where he received his Bachelor of Science degree.

Vision

My individual passions lie with ESD standards and educational development, and while there has been a great deal of work surrounding collaborative efforts with several different standards organizations, the ESDA must continue to strengthen these ties and persist in the joint efforts to best serve the industry. I strongly believe "Serving the Industry" is the main field of interest for the ESDA.

Additionally, I see a need to continue the growth in educational opportunities by expanding the ESDA's sphere of influence related to electrical overstress/electrostatic discharge avoidance by offering educational programs, certifications, technical publications, and symposia to a broader international audience and by helping to grow involvement in local ESD chapters.

I greatly enjoy the camaraderie, friendships, personal, and technical growth that I have been a part of while serving as an ESDA volunteer. As an

ESDA board member I would make it a personal goal to work towards recruiting new volunteers, encouraging them to become involved at any level, and helping them cultivate their own ESDA experiences.

I look forward to serving you, the industry, as a member of the board of directors, with the same enthusiasm and commitment that I have shown during all of my activities as an ESDA volunteer.

Jeffrey Dunnihoo

Jeff is a system level ESD architect at Pragma Design in Austin, Texas. He has 20 years of experience in system design and application in the consumer, computer, and telecommunications product sectors. Jeff has been involved with high speed interface design and protection at IBM, SMC, CMD, and most recently at NXP.



Jeff has also been a contributor to other standards bodies such as USB, IEEE 802.11, VESA DisplayPort, ESDA, and the Industry Council on ESD Target Levels. He has been granted several patents in ESD, signal integrity, and peripheral applications since graduating with a BSEE from the University of Texas at Austin.

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2012 Board of Directors Nominations continued...

Jeffrey Dunnihoo *continued*

Vision

Last Christmas, I watched an elated kid run across the carpet and pick up her new digital camera when we heard the telltale “pop.” “Why doesn’t it work?” she asked. It automatically conjured thoughts of root-cause analysis, filaments, etc. Yet all I could manage was, “Well, it got zapped.”

ESD engineering is the application of scientific principles to products that won’t make children cry!

The ESDA must continue to extend its influence beyond facilities and semiconductor segments directly to the system level product engineering and development community, which is still underrepresented in our contributors and attendees.

Many designers would thoroughly appreciate and benefit from the ESDA’s ‘collective wizardry,’ but many often cannot afford the time nor expense to fully attend symposia and quarterly workgroup meetings. We need to find new ways to not only extend our distribution of products to these key industry engineers through summary articles, webinars, and perhaps even targeted road shows, but also to incorporate the learning and feedback from these engineers.

The ESDA continues as a leader for advancing the science of ESD, and I am eager to extend ESDA’s focus to help designers apply that science for improved ESD robustness in their products.

Harald Gossner,



Harald, senior principal engineer at Intel Mobile Communications, received his degree in physics (Dipl. Phys.) from the Ludwig-Maximilians-University, Munich in 1990, and his Ph. D. in electrical engineering from the Universität der Bundeswehr, Munich in 1995. For 15 years, he has been working on the development of ESD protection concepts for bipolar, BiCMOS, and CMOS technologies with Siemens and Infineon Technologies. Recently, he joined Intel Mobile Communications overseeing the development of robust mobile systems. Harald has authored and coauthored more than 80 technical papers and one book in the field of ESD and device physics. He holds 30 patents on the same topics.

Harald has served on the technical program committees of IEDM, EOS/ESD Symposium, and International ESD Workshop. In 2010, he was responsible for the arrangements of IEW at Tutzing, Germany. Currently, he contributes to the EOS/ESD 2011 Symposium steering committee as workshop chair. He co-founded Industry Council on ESD Target Levels in 2006 and is co-chair of the council. He is involved in the further development of the ESDA advanced topics business unit.

He received the best paper award of the EOS/ESD Symposium 2005.

His contributions to education were recognized by the Outstanding Contribution Award 2010 of the ESDA education committee.

Vision

The old map of the ESD world isn’t valid anymore. We can no longer accept that there is the IC ESD designer on one side and the system EMC designer on the other without communication between both. The same holds true for ESD control and ESD protection design communities. Shrinking technologies and increasing complexity of the electronic parts urge us to think about comprehensive protection concepts which equally consider IC design, board design and ESD control measures including shielding. I am committed to spreading this message and to fostering the development of methods dealing with the new challenges. This means involvement in education and engagement to establish contacts between IC design and system design in various parts of industry. I would like to pursue these tasks as a member of the ESDA board, which has proven to be a visionary catalyst for development in electronics industry.

Michael G. Khazhinsky



Michael is currently an ESD staff engineer/designer at Silicon Labs in Austin, Texas. Prior to joining

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2012 Board of Directors Nominations continued...

Michael G. Khazhinsky *continued*

Silicon Labs, he worked at Motorola and Freescale Semiconductors, where he was in charge of the TCAD development for the new and emerging CMOS and NVM process technologies, as well as the development of ESD, latch-up, and I/O physical architecture design solutions with a focus on SOI and ESD EDA. Michael earned the M.S. degrees in electrical engineering and physics from Moscow State Institute of Electronic Engineering and the Ph.D. degree in physics from Western Michigan University. Michael is a senior member of IEEE and the ESD Association. Michael served as a member of the IRPS, IPFA, and EOS/ESD Symposium technical program committees, as well as a workshop chair and technical program chair of the EOS/ESD Symposium. He currently serves on the management committee and as the vice general chair of the 2011 EOS/ESD Symposium. Michael co-authored over 30 external papers and gave a number of invited talks on ESD, process/device TCAD, and photonic crystals. He was a co-recipient of six EOS/ESD Symposium and SOI Symposium "Best Paper" and "Best Presentation" awards. Michael currently holds fifteen patents on ESD design, with additional patents pending.

Vision

I seek to expand my responsibilities within the ESD Association. Therefore, I am ready for new challenges and opportunities that the board of directors position brings.

One of my goals is to broaden ESDA horizons into the new areas. ESD electronic design automation (EDA) is becoming an important subject for the industry and requires further development and standardization. I plan to drive ESD Association involvement in this area by collaborating with various IC design companies, integrated device manufacturers, foundries, EDA companies, and standards bodies with the goal to establish a standard design flow and methodology.

Another goal is to recruit new ESDA members. Nowadays, ESD is inseparable from chip/system design and integration. Attracting the best designers and integrators from different conferences will greatly benefit the ESD community. I would also like to increase ESD design and physics representation in the ESDA board of directors.

As a first-time candidate for the board of directors, I promise diligence, enthusiasm, and energy to perform my duties, if elected.

Alan Righter

Alan joined the ESD Association in 1997, soon after joining Analog Devices (ADI) as its external foundry ESD advisor in Wilmington, MA.



He works with ADI design/product engineering teams worldwide on pin-specific and whole chip ESD planning/design, ESD testing, ESD

design rule checking/simulation, CDM ESD testing/packaging issues, ESD failure analysis, and ESD control issues on manufacturing lines. Prior to ADI, Alan was with Sandia National Laboratories, Albuquerque, NM for 13 years, involved in IC design, test, product engineering, reliability test, and failure analysis. Born and raised in Phoenix, Arizona, Alan lives in Andover, Mass. with his wife Amanda. They have been married for 27 years and have four children; Dan (25), Sonia (23), David (19), and Nikki (14). Alan completed his BSEE and MSEE at Arizona State University in 1982 and 1984, respectively, and his PhD at the University of New Mexico in 1996. In 2007, Alan joined all standards device testing working groups (WG5.x) and is also a member of WG 14—System Level ESD. In 2008, he was appointed chair of WG 5.3.1—Charged Device Model and currently serves as ESDA chairperson of the expanded joint (ESDA/JEDEC) CDM working group. Alan is also a member of the Standards Committee (STDCOM). Alan has been active in the EOS/ESD Symposium as author/co-author of seven papers, 2010 session chair of the system level EOS/ESD session and leader of two Symposium workshops (Layout for ESD Robustness in 2007 and CDM in 2008), and is a member of the Northeast ESDA Local Chapter. Alan also is active in the Industry Council on ESD Target Levels.

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2012 Board of Directors Nominations continued...

Alan Righter *continued*

Vision

My vision for the ESD Association embraces a number of areas. I would like to help foster more collaboration between the ESD testing and manufacturing ESD control areas, to improve the modeling of real-world ESD threats in device and system ESD test methods. One way, is to foster more joint evaluation projects between standards device testing and ESD control working groups. Second, I would encourage and help the Association to develop closer ties with the AEC (Automotive Electronics Council) and Japanese electronics industry companies to foster harmonization in worldwide ESD test standards. Third, in education, I would like to increase ESD Association participation in other electronic conferences, such as the International Test Conference, and help to develop "ESD Association Series" topical journals focusing on specific ESD topics. To increase membership, I would work with the Association to develop a broader company membership base. One idea is to give improved reduced rate Symposium/IEW for small groups from smaller companies (reducing the minimum group discount threshold from the current five).

Scott Ward



Scott joined Texas Instruments in 2007 to work in the field of device-level ESD testing and ESD testing standards development. He has since expanded his work to include factory ESD control and ESD-safe handling. Prior to joining Texas Instruments, Scott worked for Cypress Semiconductor in San Jose, CA. At Cypress, his work included ESD and latch-up design and characterization, as well as device testing standards development. Since 2003, he has been a member of the ESDA working group 5.0 standards committees (device testing). Scott joined the JEDEC ESD standards task group in 2005. Scott is an ESDA member, attending every EOS/ESD Symposium since his first in 1996. Scott began his career at ZiLOG in 1995, designing on-chip ESD protection networks. Scott has an M.S. in electrical engineering from the University of Idaho (2002) and a B.S. in electrical engineering from Montana State University (1992).

Vision

This is an exciting time to be working in the field of electrostatic discharge. Performance requirements have driven the industry to lower

acceptable limits for HBM and CDM; increasing the criticality of effective factory ESD control programs. Cooperation with JEDEC enabled a joint HBM standard to be recently released and a joint CDM standard is in development. Moreover, the ESD testers themselves have not kept up with the nuances of complicated IC designs to maintain the required fidelity for measuring the new ESD levels. For the future of the ESDA technology roadmap, all of these issues will become much more critical in the next few years.

I would like to drive the ESDA organization in the following areas:

1. Better alignment between ESD device target levels and the requirements necessary for factory ESD control.
2. Drive the industry to improve the ESD stress testers compatibility to the new standards.
3. Increase the focus on electrical overstress (EOS) in the standards committees and the EOS/ESD Symposium.

I believe my background in on-chip ESD protection design, device-level standards, ESD tester issues, and factory ESD control work will enable me to serve the ESDA with enthusiasm in a wide variety of areas.

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Education

(IEW) International Electrostatic Discharge Workshop

May 16-19, 2011 Stanford Sierra Conference Center, Lake Tahoe, CA

This workshop provides a unique environment for envisioning, developing and sharing ESD design and test technology for present and future semiconductor applications. The workshop includes invited seminars, technical sessions, special interest groups (SIGs), discussion groups (DGs), and invited speakers.

Register Online At <http://esda.org/onlineregistrations.html>

Keynote and Invited Talks

The IEW will include 5 exciting talks by industry professionals

Ability of Evanescent Electric Fields to Deliver Potentially Devastating Amounts of Power Over Laboratory-Scale Distances, Cell Phone Front End ESD Challenges, ESD Design and Performance Challenges in High-Speed Serial Links of 20 Gb/s and Beyond, System Level ESD: A Networking Perspective, High Speed I/O (Transceiver) Design

Technical Program

To best uphold the workshop format for this event, the technical sessions at this year's workshop offer short introductory presentations followed by an expanded poster discussion section. The latter affords a great opportunity for raising questions, comments, and ideas with the authors and other interested attendees.

Discussion Groups

Three parallel discussion groups are offered Tuesday and Wednesday evening. Each discussion group is assigned one or more moderators who have extensive expertise with the topic and will help to guide the discussion. However, the actual discussion flow will be at the discretion of those participating in each group. Everyone is encouraged to bring along data and ideas to share that are of particular interest.

Special Interest Groups (SIG)

A special interest group (SIG) is a collaborative working team focused on one compelling topic of mutual interest. The SIG program at the IEW has been established to foster collaborative work on important ESD issues and we look forward to continued momentum throughout the year on these topics. Five SIGs are scheduled for IEW 2011. Attendees are also encouraged to form new SIGs as they see fit.

Seminars

The seminars this year cover four important topics for the changing industry with respect to ESD design. On-chip protection steadily becomes more challenging due to complex chip layout issues and requires efficient EDA tool development to prevent errors. An overview of these software applications will be given in the opening seminar. At the IC package level, advanced development of multi-chip and stacked packages requires a better understanding of their possible effects on CDM through simulation techniques. These will be reviewed in the next seminar. The increasing trend towards system on-chip and the latest applications involving analog-digital interfaces could have an impact on full chip ESD design. The third seminar will present the next wave in analog designs. Finally, the component ESD levels are currently under an industry wide consensus to be practically reduced in specs to meet the technology challenges noted, and thus forcing a new requirement for improved factory control methods at the production sites. A first-ever factory control seminar at the IEW will provide this important outlook for the audience.

Fireside Chat

“The Continued Saga of ESD Levels – Let's blame it on Aristotle!”

The new ESD target levels and any discussion of them continue to be an emotional issue. Although much of the empirical evidence and data collected by the Industry Council clearly indicate that a reduction towards practical levels are safe and promote the technology scaling and circuit performance requirements. Join us for a lively and friendly fireside chat on Monday evening to find out how far we have made progress, what else needs to be considered, and when will we change the whole industry.

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Education

**North Central Regional Tutorial
May 18-19, 2011**

Holiday Inn & Suites, Bloomington, MN

**Seminar 20.20: ESD Program
Development and Assessment
(ANSI/ESD S20.20 Seminar)**

8:00 a.m. - 5:00 p.m. -2 Days

Ron Gibson; John T. Kinnear MSEE, IBM

This seminar provides instruction on designing and implementing an ESD control program based on ANSI/ESD S20.20. The course provides participants with the tools and techniques to prepare for an ESD facility audit. This two-day course is an ESDA certification requirement for in-plant auditors and program managers who are working toward professional ESD certification. The following topics are covered in this course:

- Overview of ANSI/ESD S20.20
- How to approach an assessment
- Administrative elements
- ESD program assessment
- ESD program techniques for different applications
- Technical elements
- Overview of the assessment process
- The audit checklist and follow-up questions

It is recommended that the ESD Program Development and Assessment Seminar be taken after the Certification candidate has taken most of the other Program Manager related tutorials.

Register Online At <http://esda.org/onlineregistrations.html>

ONLINE EDUCATION

**HMM Basics: Proposed Test Method,
Testing Procedures and Round Robin
Study**

July 14, 2011 • 11:00 a.m. US/Eastern Time

Kathy Muhonen, RF Micro Devices

This tutorial will explain in detail the intent of the new HMM proposed test method. The tutorial starts with the hurdles of testing components to the IEC 61000-4-2 standard. The scope and purpose of the HMM proposed test method will be discussed. The waveform used in this test and its critical specifications are presented along with the qualified equipment used to deliver the waveform. Three test configurations are introduced to address equipment specifics and recommended grounding.

The tutorial also reviews the HMM round robin study and what data has been collected to date. The round robin consists of approximately 10 labs and four different test structures. Statistical analysis of the data will yield the degree of variability that can be expected from this type of test. Not only will the round robin determine the degree of repeatability of the test method, it is absolutely essential to conduct this study in order to elevate the test method into a standard practice. Other experimental results are also reviewed (one part, one operator, different qualified equipment for comparison).

The tutorial will summarize the important differences between the HMM proposed test method and the IEC 61000-4-2 and will reiterate the care that must be taken when testing components to a system level test.

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SiGe and Ga!

Ga Tech that is...

Dr. Steven H. Voldman

SiGe (pronounced like “Ziggy”) is Silicon Germanium (SiGe), and “Ga” is not Gallium, but Georgia. SiGe has its place in the semiconductor industry, and in Georgia – with SiGe, of course, there is work to be done in ESD protection of Silicon Germanium. Silicon Germanium started in IBM research to extend the usage of bipolar transistors for the IBM large bipolar-based servers. But, the world changed, and the “Big Iron” servers went to CMOS, then it took a long time to figure out what to do with it. Well, due to Analog Devices, it was kept alive in analog design, and then eventually found a home in RF applications. Silicon Germanium now exists in IBM, Jazz, TSMC, and other foundries around the world. A leading expert in Silicon Germanium and center for SiGe research is Georgia Tech, formally Georgia Institute of Technology.

Georgia Tech is centered in midtown Atlanta. The campus is partially integrated with the city area, with research buildings on both sides of a highway. Georgia Tech’s campus occupies 400 acres in the city of



SiGe Team (above), Professor John Cressler (right)



Atlanta, where 20,000 undergraduate and graduate students receive a technology based education.

... Ironically, I was working in the next building integrated into the Georgia Tech campus. Adjacent to the campus are “incubator” businesses buzzing with all types of startups, and small corporations. Quellan Inc, is filled with many Georgia Tech graduates (now Quellan employees) working on analog and mixed signal design.

My host for the visit was Professor John Cressler. John has a large research group working on different aspects of SiGe from cryogenics to radiation effects. John Cressler previously was at IBM T.J. Watson Research working on SiGe as part of Bernie Meyerson SiGe team.

For the ESD lecture, the majority of attendees were from the SiGe team, with about 20 attendees.

John noted that “Yes, we have ESD issues when we are doing our experimental work with SiGe”. Of course, without ESD protection devices

And the first person to do ESD work on SiGe technology? Yours truly...

Dr. Steven H. Voldman
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Manufacturer of static control products

Marise Baffleur, an International ESD Expert



Left; Marise (in red) and her team during IEW 2008
Right; With Jim Miller and members of her team at Lake Tahoe in 2007



Marise Baffleur was head of the ESD research team at LAAS-CNRS from 1997 to 2005. She has been an advisor of 10 ESD-related PhD theses. Marise is an expert for the European ESPRIT project n° EP 23643 ESDEM “ESD Protection Design Methodology (1999)” and the Institute for the promotion of Innovation by Science and Technology of Flanders (IWT-Flanders) in Belgium. She is a member of the ESD technical committees for EOS/ESD Symposium, IEW, ESREF, and IRPS. Marise holds two patents, and contributed to 21 journals and 67 national and international conferences.

Marise first started volunteering for the ESD Association as a member of the technical committee for the EOS/ESD Symposium in 1998. Marise had just starting work in the field of ESD at LAAS-CNRS after a career in smart power technologies. The ESD

team at LAAS-CNRS started with two permanent researchers and PhD students in cooperation with industrial companies such as CNES, Freescale, ON Semiconductor, STMicroelectronics, and DGA. The team now includes four permanent researchers working on ESD protections for both advanced CMOS and smart power technologies, system level ESD and recently, thin-film ZnO-based varistors.

Given the convergence between EMC and ESD approaches, Marise founded a workshop called EOS/ESD/EMI. At its origin the first workshop, held in 2002, was a national event in France. The workshop was held again nationally in 2004. For its third year in 2006, it was international and had 50 attendees. That same year, Jim Miller contacted Marise about being part of an exploratory committee to set up an International ESD Workshop (the

IEW) sponsored by ESDA alternatively held in the USA and Europe. In 2008, Marise became the local organizer for Europe, bringing the International ESD Workshop (IEW) of the ESDA to it's first European location in Port d'Albret (FRANCE).

Marise says that being part of both the EOS/ESD Symposium and IEW committees allows her to interact and learn with top international experts in the field of ESD. It has also helped her to become recognised both in France and and Internationally as an ESD expert.

Marise lives in France. She is married and has two daughters. Some of her favorite hobbies include hiking, skiing, Qi Gong, photography, and cooking.

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Interference Technology publishes practical solutions for ESD/EMC phenomena, plus directories, reference information & supplier guides. Subscribe online at www.interferencetechnology.com

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Tech Talk

The January/February 2011 Tech Talk column discussed the process of developing a Work-In-Progress (WIP) and how a WIP becomes a draft standard. This issue will cover how a draft standard becomes a full standard.

How a draft standard becomes a full standard.

1. The working group (WG) identifies interested parties who were not part of the document development process to participate in an industry review of the document.
2. The Standards Program Manager formats and prepares the document for a 45-day Industry Review.
3. The document is distributed using FileOpen Encryption software along with a comment compilation spreadsheet.
4. A Board of Standards Review Form 8 (BSR8) is filed with ANSI by the Standards Program Manager. See ANSI BSR8 and BSR9 Forms for more information.
5. After the close of the 45-day comment period, the Standards Business Unit Manager classifies all of the comments received as Editorial, General, or Technical.
6. The comments are then forwarded to the WG for adjudication.
7. Once adjudication is complete, a formal letter is drafted and sent to each commenter outlining

their comments and the WG's response and/or action taken as a result of the comments.

8. If technical changes are made as a result of comments received during the Industry Review period, the document goes back to a WIP and the process starts from the WIP stage.
9. If there are no changes or only editorial changes made, a Board of Standards Review Form 9 (BSR9) is filed with ANSI by the Standards Program Manager. See ANSI BSR8 and BSR9 Forms section below for more information.
10. Upon BSR9 approval the Standards Program Manager formats and prepares the document to be published as a full standard.

What are the ANSI BSR8 and BSR9 forms?

The ANSI Board of Standard Review Form 8 (BSR8) initiates an announcement in ANSI's Standards Action publication. The announcement notifies interested parties and stakeholders that a document is available for a 45-day public review and comment period. The announcement includes an explanation of the need for the



project, the scope of the document, information on obtaining a copy of the document, and where comments should be submitted. The BSR8 form is initiated when a document is published for industry review.

After a document has gone through the standardization process it must be submitted to ANSI within one year for final approval using the ANSI Board of Standards Review Form 9 (BSR-9). The BSR-9 form provides evidence of consensus and demonstrates compliance with ANSI's Essential Requirements. If there are no questions or unresolved negative votes or comments, then the ANSI PSA staff is authorized to approve the document. Any abnormalities or questions are forwarded to the BSR for review. A document must be published within six months of approval. Normal approval is completed within one week.

Dangelmayer Associates, L.L.C.

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As secretariat of ISO/TC 209, IEST offers ISO 14644 and ISO 14698 standards, as well as peer-approved standardized procedures, IEST Recommended Practices.

Standards

ESD Association Meeting Series

June 7-12, 2011
Sheraton Mission Valley San Diego Hotel
1433 Camino Del Rio South
San Diego, CA 92108

Tuesday, June 7

Education 8:00 - 5:00

Wednesday, June 8

TAS 7:00 - 5:00
Steering 1:00 - 5:00
ExCom 6:00 - 9:00

Thursday, June 9

BoD 8:00 - 5:00

Friday, June 10

TAS 8:00 - 5:00
JWG, Device Testing (CDM) 8:00 - 12:00
WG-3, Ionization 8:00 - 12:00
WG-12, Seating 8:00 - 12:00
WG-15, Gloves 8:00 - 12:00
WG-10, Handlers 1:00 - 5:00
WG-13, Handtools 1:00 - 5:00
WG-20.20, S20.20 1:00 - 5:00
JWG, Device Testing (HBM) 1:00 - 4:30
WG-5.0, Device Testing 4:30 - 5:30
Hospitality Suite 5:30 - 6:30

Saturday, June 11

WG-2, Garments 8:00 - 12:00
WG-53, Compliance Verification 8:00 - 12:00
WG-4, Worksurfaces 8:00 - 10:00
WG-9, Footwear &
WG-97, Footwear Systems 10:00 - 12:00
WG-5.2, Device Testing (MM) 8:00 - 9:30
Adhoc-5.0, Device Testing (CBE) 9:30 - 10:30
WG-5.5, Device Testing (TLP) 10:30 - 12:00
Marketing & Communications 1:00 - 5:00
WG-11, Packaging 1:00 - 3:00
WG-5.4, Device Testing (TLU) 1:00 - 2:00
WG-5.6, Device Testing (HMM) 2:00 - 5:30
WG-1.0, Wrist Straps 3:00 - 4:00
WG Chair Meeting 5:30 - 6:30
ESDA Mixer - All Invited 6:30 - 7:30

Sunday, June 12

WG-7, Flooring 8:00 - 12:00
WG-14, System Level ESD 8:00 - 12:00
WG-17, Process Assessment 8:00 - 12:00
Human Resources 10:00 - 12:00
MAR/STDCOM 1:00 - 4:00
Awards Committee (Closed Meeting) 4:00 - 5:00

Monday, June 13

Device Design Seminar 8:00 - 5:00

Tuesday, June 14

Device Design Seminar 8:00 - 5:00

You are invited!

Please join us at the June meeting series Hospitality Suite,
Friday, June 10th from 5:30-6:30 PM

The Hospitality Suite is a meant to allow interaction of volunteers. New volunteers, guests, and seasoned volunteers will have the opportunity to visit and get to know each other, encouraging new friendships and increased volunteer involvement. Suite location will be posted at the event.

Come and be part of the ESDA family, hear some stories, and join the camaraderie!

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info@esda.org

Symposium



Robert J. Gauthier Jr.
Symposium General Chairman

Dear Colleagues, Friends,
Companions, and EOS/ESD
Enthusiasts,

On behalf of the ESD Association and the 2011 Symposium Steering Committee, I would personally like to invite you to the 33rd International EOS/ESD Symposium located at the Disneyland Hotel in Anaheim, CA. Founded by fifty German families in 1857 and incorporated on February 10, 1870. Anaheim - "Ana" refers to the Santa Ana River and "heim" is the German word for home. The city's early pioneers considered this location to be their "home by the river." The combination of the Symposium's schedule of events and venue location will give you plenty of opportunities for professional and personal development. Let me give you a quick overview of what is planned at this year's exciting Symposium:

Tutorials... Education is the backbone of today's fast moving world. We will kick things off with a set of academic and professional certification tutorials on Sunday and Monday and then continuing on Thursday. In addition to offering alternate versions of the

ESD Basics and the S20.20 Seminar, four tutorials have been significantly revised this year to keep you current on ESD Program Management: "System Level ESD/EMI-testing to IEC and Industry standards", "Calculations", "Ionization and Answers for the Program Manager", and "Cleanroom Considerations for the Program Manager". To support the renewed interest in ESD engineer and ESD technician certifications from iNARTE, we are offering four exam preparation tutorials: "ESDA Standards Overview", "Expanded ESD Standards from Industry", "System Level ESD/EMI-testing to IEC and Industry standards", and "Calculations". Other new or revised tutorials this year include: "Electrical Overstress in Manufacturing and Test", "ESD Design Using Interactive Parameterized Mixed-Mode Device and Circuit Analysis", "Training Internal Assessors or Consultants to ANSI/ESD S20.20", "Integrated ESD Device and Board Level Design", "Methodologies for Determining the Impact of Static Control Methods", "Program Manager Course Curriculum updates", "Automated Process Packaging Issues", and an interactive tutorial "ESD Measurements and Event Detection". Overall, there is an excellent combination of basic, intermediate, and advanced tutorials for attendees to learn from.

Technical Sessions... Your gateway to learning about the latest technical innovations in the area of ESD. The opening of the Symposium will start with the Awards Breakfast on Tuesday morning followed by an exciting keynote presentation by John B. Bacon, Ph.D., P.E., NASA Systems Integrator, who will talk about "Electrostatic Discharge

Issues in International Space Station Program Extravehicular Activities". The technical program will span Tuesday to Thursday with 52 outstanding talks, including two invited exchange papers. The technical presentations are spread across 12 technical sessions covering hot topics in the categories of advanced CMOS, case studies, high voltage and RF ESD challenges, device physics and modeling, ESD EDA tools, factory and materials, system level ESD, and ESD testing. Presentations will be given by experts working on leading edge research and development in these areas. As always, please plan to meet the authors to discuss their new and exciting research in the author's corners following the technical sessions.

Workshops... Share professional issues and experiences, find solutions, or openly discuss ideas. The program includes 6 workshops spread across Tuesday and Wednesday afternoons which will provide you the forums to have detailed discussions, receive feedback on burning questions, and learn from colleagues in an informal environment. Prepare your questions today and submit them to the workshop moderators or bring them directly to the workshops you are interested in and start discussions on these hot topics. We look forward to seeing you at the workshops which "spark" an interest with you!

Industry Exhibits... Offering new ESD products and services, our colleagues from many companies will be happy to meet you in the exhibit hall, starting with the welcome reception on Monday evening and continuing until the exhibits close on Wednesday afternoon. This is a unique opportunity

Continued on page 14

Symposium *continued*

to find the ESD products or services you have been looking for or a chance to talk to the professionals with hands-on experience on static control methods, evaluation techniques, ESD testing hardware, and many other ESD solutions. Complimentary coffee will be available in the exhibit hall, so please stop by and visit the exhibitors. New in 2011- on Tuesday we will be offering a special exhibitor demo session in the exhibit hall in parallel to the technical sessions. The "Demo Day" session will allow exhibitors to give a fifteen minute video presentation with an additional five minute question and answer period.

Awards... Are you wondering which paper has won the 2010 Symposium Outstanding Paper Award (voted by the Symposium attendees), the Best Paper and Best Student Paper Awards (voted by the TPC Awards Committee), and the Friendship Award, given to the authors of the Best Paper at the RCJ's ESD Symposium in Japan? This exciting information will be revealed during the Symposium Awards Breakfast on Tuesday morning. We look forward to seeing you at the awards breakfast.

"We keep moving forward, opening new doors, and doing new things, because we're curious and curiosity keeps leading us down new paths." Walt Disney. Please join us at the 2011 EOS/ESD Symposium located on the home by the river. On behalf of the ESD Association and the 2011 Symposium Steering Committee we look forward to providing a venue which helps to enable moving your professional career forward.

Robert J. Gauthier Jr.
Symposium General Chairman

Q & A

Q. I'm looking for some guidance regarding the use of ESD flooring. My questions are:

- Between static dissipative or static conductive, is one considered better than the other?
- How is it determined which product is more appropriate for a given use?
- Are there protocols associated with either type? (Footwear grounding, straps, etc?)
- Is there an ideal surface resistance range that covers a majority of projects?
- What are the advantages and disadvantages between rubber and vinyl?

A. These are fairly often asked questions. There are lots of choices in flooring materials today, you do need to be careful in the selection since it is an expensive purchase. For those that want to use the floor as either the main grounding path for personnel or as a back-up in an ANSI/ESD S20.20 compliant or certified facility,

the combination of floor and footwear becomes the primary quantity to measure. In the current release of S20.20 (2007) two methods are used to qualify the floor and footwear system. In the first, the resistance to ground from a person, through their footwear while standing on the floor, has to be less than 35 megohms ($<3.5 \times 10^7$ ohms). If the floor and footwear combination is greater than 35 megohms but the floor resistance to ground is less than 1 gigohm ($<1 \times 10^9$ ohms) then a walking test according to ANSI/ESD STM97.2 must be used to qualify the floor and footwear combination. The result of the walking test must be less than 100 volts (or other user defined value).

In order to have a combined floor and footwear resistance of <35 megohms the floor itself has to be just about 10 megohms or less to ground. This means that in almost every case, a conductive range floor is needed. The vast majority of floors being installed today are considered conductive and

are in the range of 2.5×10^5 ohms to 1×10^6 ohms when measured according to ANSI/ESD S7.1 (soon to be STM7.1 without significant content change). A 1 megohm floor $\pm 10\%$ would be considered ideal by most today.

We cannot get into details regarding features and advantages of the various materials but it can be stated that there are both vinyl and rubber based flooring materials that will meet the requirements for grounding of personnel as stated above. There are also vinyl and rubber materials that will not meet the requirements as stated above so it is necessary to thoroughly review product literature before purchase.

The response given is a service to industry; the ESDA is not responsible for content.

The users of this information need to determine the suitability of the response.

UNIVERSITY GRANT FUNDING

by Charvaka Duvvury

Why Do We Give ESDA Research Grants?

The mission of the ESDA has been to fund university research grants in order to provide an opportunity to professors and researchers to investigate new ESD phenomena. While it establishes a better understanding of the subject, the intent has been to also promote student development for their careers in ESD. The Education Committee is grateful that the ESDA Board of Directors has strongly supported this process during the last several years, even when the times have been tough with downturns in the economy. Indeed the values for both education and research never cease. However, the general question that often pops up is whether the expected value has been achieved. Although it

is never easy to measure in a quantifiable manner, the intrinsic benefit is always there whether the grant money was spent on work that generated new results or in facilitating student research that led to better expertise in the field. In the end, all of it eventually benefits the community and the ESDA is better for it for enabling the common good. Here is a brief summary of the recent grants.

The Most Recent ESDA Grants Awarded:

- 2010: Professor William Greason, University of Western Ontario, Canada
- 2010: Professors Gaudenzio Meneghesso and August Tazzoli, University of Padova, Italy
- 2008: Professor Elyse Rosenbaum, University of Illinois, USA

- 2007: Professor Kathy Muhonen, Penn State University, USA
- 2007: Professor William Greason, University of Western Ontario, Canada
- 2005: Professor Kaustav Banerjee, UC Santa Barbara, USA

At the University of Illinois, Prof. Rosenbaum received a grant in 2008. This grant was used to support student work and conference travel for presentations. Their total research work includes: Latchup modeling, On-chip protection, studies of CDM, and high speed ESD designs. They have published three informative papers on these subjects. One key manner in which the ESD grant monies have helped them is in subsidizing the research work in conjunction with other external grants.

Continued on page 16



Professors Gaudenzio Meneghesso (center Front) and students of the University of Padova, Italy

Education

UNIVERSITY GRANT FUNDING continued

At the Penn State University, Professor Muhonen was awarded the 2007 grant for research in the very fast transient pulse system standard. This work produced important results for the ESDA that is currently helping the Standards Committee.

At the University of California at Santa Barbara, Prof. Banerjee received one grant in 2005. Their research has been in exploring ESD issues in emerging CMOS technologies. They have published three novel papers to expand the knowledge of the importance of ESD in these new areas. Partial funding from the ESDA has been acknowledged.

At the University of Western Ontario, Prof. Greason received

grant money for 2007, and more recently in 2010 for research work on ESD monitors. Prof. Greason has been an extensive contributor in the field of electrostatics, with specialization in research involving charging of materials, modeling of ESD events, ESD phenomena in micro gap structures. The 2007 grant was used for both student support and equipment and the outcome of the research resulted in two ESD Symposium papers. The research with the new grant money is currently under progress.

At the University of Padova, Profs. Menghesso and Tazzoli were awarded the 2010 grant for work on new transient pulse systems in MEMS technology. The focus of their work has been on ESD in Micro-machines and Organic Devices. The work based on the

grant money is also currently under progress and the results are expected to be published by 2012.

Why Should We Continue to Support University Grants?

The ESDA research grant funding continues to generate some significant research to the field. Of further importance is that it continues to create new ESD graduates who will carry innovative work in the industry. At a time when there is a paradigm shift in the field of ESD and the keen awareness for a new technology roadmap, every bit of research funding provided by the ESDA is almost guaranteed to not only help the industry but also help the ESDA to serve the industry and achieve better global influence.

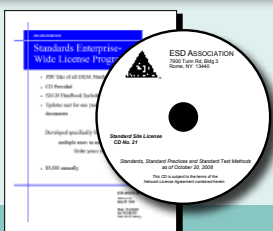
COMPETITION FOR 2011 UNIVERSITY RESEARCH GRANTS

The ESD Association is pleased to announce that the Board of Directors has approved a competition for two university research grants of \$10K each in the field of ESD. The deadline for applications is June 30th 2011. The submitted grants will be considered for proposed research in the areas of Device & Design, System Effects & Design, Factory Control, Materials Development,

and Test Methods. Anyone wishing to submit a proposal must contact the ESDA at info@esda.org. The submitted proposals should include the title, purpose, approach, and the expected outcome of the work. The proposal work should preferably keep in perspective the ESD Technology Roadmap as published on the ESDA web site.

For any further details please contact:

Lisa Pimpinella (lpimpinella@esda.org)
Kathy Muhonen (Kathleen.Muhonen@rfmd.com) or
Charvaka Duvvury (c-duvvury@ti.com).



Standards Enterprise-Wide License Program

Developed specifically for companies who have multiple users in multiple facilities, the Program includes: PDF files of all ESDA Standards Documents on CD, S20.20 Handbook Included.

For information on ESD Association Standards Enterprise-Wide License Program visit;
http://www.esda.org/pub_standardlicense.html

Bringing ESD on Campus to the next generation of ESD professionals

Dr. Steven H. Voldman

The ESD Association established the ESD on Campus program as an outreach to students, faculty, and universities. In the past, the ESD Association only interfaced with universities who were active in research and development of ESD. Since the start of the ESD on Campus program in 2005, Association interaction has expanded to include colleges and universities that do not necessarily have existing ESD, EOS, or latchup focus in their engineering curriculum. Our hope is to promote research and development in the area of ESD. The ESD on Campus program is inclusive on a global spectrum, visiting universities and colleges in the U.S., Europe and Asia: Georgia Tech, Vanderbilt University TN, UT Austin-TX, Universiti Sains Malaysia TUV Vienna, University of California at Riverside, University of Central Florida, Beijing University, National Tsing Hua University, City University of Hong Kong, Stanford University, University of Buffalo NY, Arizona State University, Mahanakorn University-Thailand, Chulalongkorn University-Bangkok, Kasetsart University-Bangkok Thammasat University-Bangkok, Mapua Institute of Technology-Philippines, Universiti Sains Malaysia, National University of Singapore, Nanyang Technical University, University of Vermont, National Chiao Tung University-Taiwan, Zhejiang University-China, Fudan University-China, JiaoTung University-China, Universiti Sains Malaysia, National Taiwan University of Science and Technology (NTUST), National Taiwan University

(NTU), University of Wisconsin-Milwaukee (UWM), and University of Illinois Urbana-Champaign (UIUC).

What does the ESD on Campus program provide? The ESD on Campus program benefits include:

- Formal lectures to both students and faculty.
- Visitation of ESD Association representatives with faculty members, department heads, and the president of the university.
- ESD Association literature package for students and faculty.
- ESD Threshold Magazine article including photo of faculty and students.
- Exposure on the “ESD on Campus” section of the ESDA website.
- ESDA distribution mailing list.
- ESD Symposium faculty reception for students and faculties.
- Networking for students and faculty with other universities.
- Networking for students and faculty with industry professionals in the area of ESD design and protection.



Why is this important? For faculty and students, the value will broaden the educational experience of electrical engineering students to become familiar with present day problems in industry. Universities can add ESD curriculum for its student population who are studying electrical engineering, material science, and systems. Students will learn about ESD issues that are occurring in “real world” industry environments. Students will benefit through the contacts for industry internships, and professional job opportunities. Students will also benefit by meeting ESD experts who are active in today’s industry. In this way, it will improve their professional growth and awareness.

How do you initiate a visit? Contact the ESD Association office at info@esda.org to arrange for an invited speaker and allow for speaker availability.

Best regards,
Steven Voldman
ESD on Campus Program Manager

Association

ESDA ANNOUNCES A “NEW” CORPORATE SPONSOR PACKAGE

Corporate sponsor packages have been developed to offer a variety of benefits to our manufacturing and industry supplier communities. These packages are grouped to include a variety of services for users and vendors that offer significant discounts over individual prices including individual memberships. You can save as much as 45% over purchasing the items separately. Sign up now to reduce your cost of sending multiple individuals to the Symposium, and save on a variety of ESD Association programs and services during the coming year.

These user packages are tailored to meet the needs of our Industry OEM/Contract Manufacturer Community.

CSP USER PACKAGE:

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These vendor packages are tailored to meet the needs of our Industry’s Supplier Community.

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- 1 Threshold Institutional Listing

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To sign up for one of our Corporate Sponsor Programs call the ESD Association at 315-339-6937

Local Chapters

“Local Sparks”
The Local Chapter Connection

Quick Links to ESD Local Chapters and affiliated organizations

- ASEMEP ESD Council • aec.asemep.com.ph
- Asociación ESD de Mexico • www.esdmexico.com
- Indian Chapter no website available
- North Central Chapter • www.esdnorthcentral.org
- Northeast Chapter • www.nechapter-esda.org
- Silicon Valley EOS/ESD Society • www.esdiscovery.org
- Texas Chapter • www.Centxesdassoc.homestead.com



Starting a local chapter or a student chapter can be a very rewarding and educating experience. Getting people together from the EOS/ESD industry or academia in your area can develop a whole new awareness of ESD issues and solutions. Regular chapter meetings provide a continuous exchange of information, making the annual symposium, sponsored by the ESD Association, that much more rewarding.

For more information on starting a local chapter or student chapter visit <http://esda.org/chapters.html> Or contact the ESD Association at 315-339-6937.

NORTH CENTRAL CHAPTER ANNUAL MEMBERSHIP MEETING AND DINNER

The North Central Chapter held its annual Membership Dinner Meeting on March 14th. The annual meeting usually draws a good attendance and this year was no exception with nearly 40 members and guests present.

The guest speaker was Ronald Gibson from Stephen Halperin and Associates, Ltd. Ron’s presenta-

tion discussed “Major Issues Companies Face with S20.20 Certification and How to Address Them”. The presentation was well received and there was much discussion afterward.

ESDA Senior Vice President, Leo G Henry also attended the meeting and provided a presentation on the current activities of the Association.

Join our Groups on



Join us on LinkedIn for exciting discussions on ESD Topics

- ANSI/ESD S20.20
- EOS/ESD Symposium
- ESD Association Standards
- ESD Related Discussions

Calendar of Events

May 4-5, 2011

Northeast Local Chapter RTP
ESD Damage - the Surprisingly
Dominant Failure Mechanism • Sources
of and Protection from Electrical
Overstress (EOS) in Manufacturing and
Test • Packaging • ESD Test Equipment
Workshop: Uses and Pitfalls of ESD
Measurements

<http://esda.org/onlineregistrations.html>

May 16-19, 2011

5th Annual International Electrostatic
Discharge Workshop (IEW)
Stanford Sierra Conference Center, Lake
Tahoe, CA

May 18-19, 2011

NC RTP
ESD Program Development &
Assessment (ANSI/ESD S20.20 Seminar)
Holiday Inn & Suites Bloomington, MN
<http://esda.org/onlineregistrations.html>

June 7-12, 2011

ESD Association Meeting Series,
Sheraton Mission Valley San Diego Hotel,
San Diego, CA

June 13-14, 2011

ESDA Essentials for Device Design
Sheraton Mission Valley San Diego Hotel,
San Diego, CA

July 14, 2011 Online training

HMM Basics: Proposed Test Method,
Testing Procedures and Round Robin
Study
<http://www.esda.org/documents/HMM7-2011.pdf>

June 14-16, 2011

2011 Annual Meeting of the Electrostatics
Society of America
Case Western Reserve University,
Cleveland, OH, USA
<http://www.electrostatics.org/conferences>

September 8-11, 2011

ESD Association Meeting Series,
Disneyland Hotel, Anaheim, CA

September 11-16, 2011

EOS/ESD Symposium and Tutorials,
Disneyland Hotel, Anaheim, CA

Visit ESDA on the Web

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EXHIBIT SPACE AVAILABLE

Nearly 30 exhibitors have already committed to the 2011 EOS/ESD Symposium. There are still many good spaces available, but they are going fast. To reserve your space and for information on exhibiting, contact the ESD Association, 7900 Turin Road, Building 3, Rome, NY 13440; phone: 315-339-6937, fax: 315-339-6793. To view the complete list of exhibitors, visit the ESD Association web site at www.esda.org.

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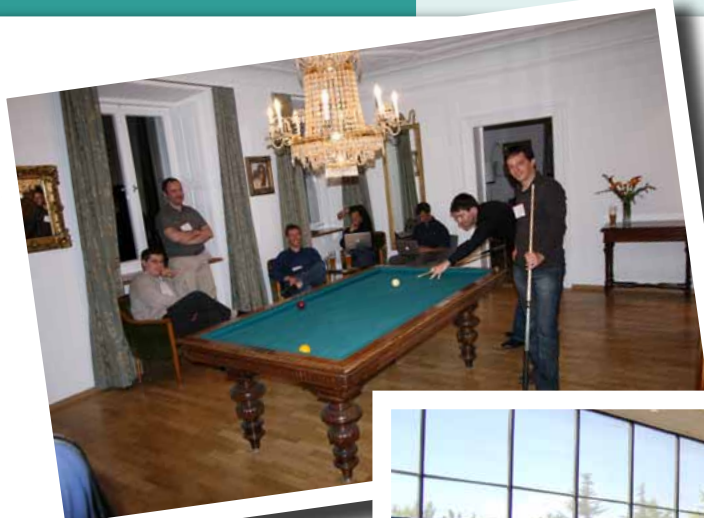
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Threshold™ is published six times a year by the ESD Association, a not-for-profit corporation. It strives for the advancement of theory and practice of electrical overstress avoidance and of allied arts and sciences and the maintenance of a high professional standing among its members and others.

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September/October	Aug. 1
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