

News bits

2001 Symposium scheduled

The 23rd annual EOS/ESD Symposium, sponsored by the ESD Association, is scheduled for the Oregon Convention Center in Portland, Oregon, September 9-13, 2001. For more information, visit the Association's web site at www.esda.org or contact Association headquarters.

Certification exam set for September 14, 2001

The ESD Association will sponsor the ESD professional certification exams in conjunction with the 2001 EOS/ESD Symposium in Portland, OR. The ESDC engineer and ESDC technician exams are scheduled for Friday, September 14. Watch for additional details on the exams and educational tutorials later in the year.

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2000 EOS/ESD Symposium



One for the record books

While Olympic athletes competed "down under," the 2000 EOS/ESD Symposium smashed all kinds of records in Anaheim, California.

All the signs were there, starting in January with the paper submissions. The trend continued over the summer as early registrations poured in and the Disneyland Hotel filled up. As the Symposium steering committee reviewed the early data, last year's general chair Tom Diep was fidgeting in his office over an attendance challenge he issued to Koen Verhaege, the 2000 general chair. Who would wear the Mickey Mouse ears? Before on-site registration even opened, the question was answered and Tom appeared at the Sunday night ESD Association volunteer recognition dinner sporting new headgear.

Coping with the overflow

Meanwhile, Symposium volunteers and staff were working diligently with the hotel and convention center to accommodate the higher than anticipated attendance. Hoping to minimize any potential inconvenience to

the attendee, the effort was started well in advance, but feverish behind-the-scenes activity continued on site:

more tables and chairs for meeting rooms, extra buses for tours, relocating luncheons, and praying for good weather to accommodate outside functions.

Some activity was more visible as Association board members and Symposium steering committee members were pressed into extra duty at the registration desk and the Association booth. As general chair Koen Verhaege commented, "The most amazing experience was as-

Symposium week was bigger than ever...

Koen Verhaege

continued on page 7

From the Threshold chair

Threshold debuts new look

Redesign is here! Send us your comments.

We have done as we have promised. We have made the "change" and we hope that you like it. The new look is intended to make Threshold more readable, more attractive, more professional, and of more value to you, the reader. Please take some time to "look over" the whole issue and send us your "gut" feeling. We promise to consider ALL constructive comments, but we reserve the right to publish only your positive feedback



Leo G. Henry
Threshold Chair

Please look for the September standards update on pages 10-11 and make a note of the dates for the February 2-4 standards meeting series to be held in Portland, Oregon.

So here we are again. You know the now famous saying: Repetition is the "mother" of all indoctrination events. So I will repeat. Don't just promise that you will

"write up your ideas" and send them in

soon. Do it this week. Any ESD related topic will be reviewed. Threshold deadlines appear in each and every issue on page 2.

We may have changed the "look" of Threshold, but one fact has not changed: it is still your newsletter. Please participate and help it remain successful. The editor and I will be happy to publish your contribution. Please send articles, news, updates, letters to the editor, and other information to Mike Brandt (mtb@mrlweb.com).

Until next issue,

LeoG

Threshold

THRESHOLD™ is published six times a year for the members of the ESD Association. The association is 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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Threshold™ Publication Schedule

Issue	Deadlines
January/February	Dec. 1
March/April	Feb. 1
May/June	April 1
July/August	June 1
September/October	Aug. 1
November/December	Oct. 1



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Calendar of events

December 2000

Silicon Valley EOS/ESD Society Holiday Party: December 14, California Hornblower, Pier 33, San Francisco, CA, www.esdsiva.org

January 2001

Midwest ESD Chapter Meeting: January 10, TBD, ESD Issues for Contract Manufacturers and Their Customers, Joe Jesse, Key Industries, Bimbo's Restaurant, Palatine, IL, www.midwestesd.org

ESD Northwest Chapter Meeting: January 10, TBD, www.esdnw.org

Silicon Valley EOS/ESD Society Membership Meeting: January 16, Ramada Inn, Sunnyvale, CA, www.esdsiva.org

Northeast ESD Chapter General Education Meeting, Facility Tour, KeyTek, January 17, www.nechapteresda.org

February 2001

ESDA Standards and Committee Meetings: February 2-6, Doubletree Hotel, Portland, OR, 315-339-6937, www.esda.org

Midwest ESD Chapter Meeting: February 7, Facility Tour, Tellabs Operations (Tentative), Bolingbrook, IL, www.midwestesd.org

Silicon Valley EOS/ESD Society Membership Meeting: February 20, Ramada Inn, Sunnyvale, CA, www.esdsiva.org

March 2001

Midwest ESD Chapter Meeting: March 7, ESD/EMI Testing to IEC 1004-2, August Greidanus, Siemens Medical Systems, Bimbo's Restaurant, Palatine, IL, www.midwestesd.org

DISKCON Asia-Pacific: March 14-15, Singapore, www.idema.org

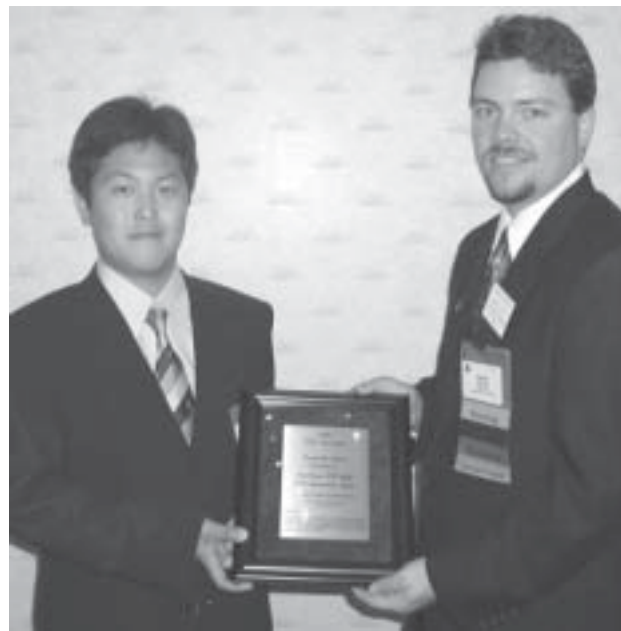
Association news

Jeremy Smith earns 1999 Symposium paper & presentation awards



Jeremy Smith, left, of Motorola's Somerset Design Center in Austin, TX, received the 1999 EOS/ESD Symposium Best Paper and Best Presentation awards for his paper An Anti-Snapback Circuit Technique for Inhibiting Parasitic Bipolar Conduction During EOS/ESD Events. The awards were presented at the 2000 Symposium by Mark Kelly (right), Symposium vice chair. The Best Paper is based on technical content and is chosen by the Symposium's technical program committee. The Best Presentation is based on presentation quality and style and is determined by the attendees.

Paper from EOS/ESD Symposium-Japan presented in Anaheim



Among the regular invited papers at the EOS/ESD Symposium is the best paper from the RCJ EOS/ESD Symposium-Japan. This year's paper, A Study of Wafer-Level ESD Testing by Kenichi Yokoi and Takeshi Watanabe of NEC Corporation, Kanagawa, Japan, was presented by Yokoi at the Symposium's opening session. In special recognition of this work, Mark Kelly (right), Symposium vice chair, presents the Symposium's Friendship Award to Kenichi Yokoi.

Ron Gibson honored for distinguished contributions

Ron Gibson, chair of the ESD Association's standards committee, has received the Association's annual Outstanding Contributions Award.

Selected by the Association's board of directors, the award recognizes distinguished contributions, service, leadership, and achievement in the field of EOS/ESD.

Ron's involvement in the Association started with the formation of the very first local (and first international) chapter, the Canadian Chapter of the ESD Association, serving as its first president.

Today, however, Ron is most frequently noted for his work in the Association's standards development activities, serving as standards committee chair. Ron also is the Canadian representative to the International Electrotechnical Commission (IEC) in the area of electrostatic discharge. As such, he plays a pivotal role in the development of worldwide ESD standards.

Ron led the development of ESD Standard S11.31 - Shielding: Bags. His measurements of the energy inside the bag from an external ESD event showed the correlation of discharge energy to device failure. The preparation of that standard



Ron Gibson



Don Pierce, Ph. D. (left), presents Ron Gibson with the Association's Outstanding Contributions Award during the Association's annual luncheon in conjunction with the 2000 EOS/ESD Symposium.

was a tour de force with an outstanding design of experiments and analysis of variance of the round-robin data. Indeed, it set the standard for standards development.

He also led the working group that developed ESD Standard S11.11 - Surface Resistance.

Perhaps, however, his most significant contribution to ESD standards was providing the leadership that led to the development of the ANSI/ESD Standard S20.20. This year Ron and Association president John Kinnear trained the first set of ISO 9000 auditors in the procedures for auditing according to S20.20. The Celestica, Inc. plant in North York, Ontario where Ron works, became the first facility to be audited and certified to S20.20.

In addition to his standards role, Ron was elected to the Association board of directors, serving as vice president, senior vice president and president. During his tenure as senior vice president, he devel-

oped the headquarters policies and procedures that are still in place today.

Ron has also been active with the EOS/ESD Symposium, serving on the technical program committee and teaching in the tutorial program. In 1995 he was the Symposium's co-general chair.

A graduate of Toronto University in 1979, Ron is Celestica's corporate ESD control manager. Over the years he has received numerous awards from the company, mainly in the areas of manufacturing achievement.

Ron is an avid hockey player, a goalie, playing with the same team for the past 15 years. Ron has also recently become a golfer. According to Don Pierce, Association past president, and others who have played with him, there is little doubt from watching his golf swing that he is, indeed, a hockey player.

Ron lives in Toronto with his wife Edna and their son and daughter. He is a devoted family man and has coached his children's baseball and soccer teams. He has also been a Cub and Boy Scout leader.

Association news

Volunteers--the heart and soul of the ESD Association

Volunteers . . .

- They develop standards.
- They plan tutorials.
- They hold office and serve on the board.
- They speak in behalf of the Association.
- They plan receptions.
- They review and select technical papers for the Symposium.
- They serve as moderators, mentors, monitors, and panelists.
- They create educational programs.
- They work in the Symposium registration booth.
- They write articles for Threshold.
- They perform a myriad of other tasks that make the ESD Association and local chapters run smoothly.

There are 240 volunteers who give their time and talents to the ESD Association.

On Sunday evening preceding the Symposium, 131 volunteers attended the Volunteer Recognition Dinner, receiving the thanks of the Association for their efforts and contributions. The evening also provided the Association the opportunity to extend extra recognition to several volunteers who made special contributions during the year.

ESDA president John Kinnear sums up the contributions with "Volunteers are the heart and soul of the ESD Association. Without the volunteers, the ESD Association would not be as successful as it is. Even Mickey agrees."



Koen Verhaege (left) receives a plaque from Association president John Kinnear for his work as 2000 Symposium chair.



Koen Verhaege, (center), 2000 Symposium chair, thanks Mark Kelly for his efforts above and beyond the normal as 2000 Symposium vice chair.



Symposium technical program chair Steve Voldman (center) recognizes the work of Al Wallash in initiating, developing, and supporting the magnetic recording sessions at the Symposium.



For his efforts in spearheading the military adoption of S20.20, Steve Gerken (left) receives a dozen golf balls from Ron Gibson, standards chair.



Tom Diep (left), chair and emcee of the volunteer recognition dinner, lost a wager regarding the total attendance at the 2000 EOS/ESD Symposium. A set of Mickey Mouse ears was presented by Association president John Kinnear to commemorate Tom's forecasting prowess.

Association introduces S20.20 certification program, names DNV as first S20.20 registrar

The ESD Association is introducing a new program that will allow companies to be certified to ANSI/ESD Standard S20.20. In conjunction, the Association has certified DNV Certification, Inc. as the first ISO 9000 Registrar in the U.S. to conduct audits according to S20.20.

This program is similar to ISO 9000 with certified registrars independently assessing a company's ESD Control program and issuing a formal 20.20 certification. The ESD Association will do the program requirements, registrar training, and registrar witness audits. The registrars will do the actual assessments of the companies. This independent assessment of a company's ESD control program could be performed as part of the company's ISO 9000 audit or as a separate audit.

In developing the program, the Association worked with DNV Certification on a pilot project. The Association developed the requirements for the program, trained the DNV auditors, and arranged for a witness audit to be performed by DNV at an electronics manufacturing facility. As a result of this effort, DNV is now certified to audit according to ANSI/ESD 20.20. The Association is also in contact with other ISO 9000 registrars to expand the number of such firms certified to conduct the audits.

Headquartered in Houston, Texas, DNV Certification is a market leader in management systems certification in North America, having issued over 3,000 certificates for ISO 9000, QS-9000, ISO 14001 and related standards. The firm has auditors throughout North America with regional offices in River Edge, New Jersey; Atlanta, Georgia; Detroit, Michigan; Long Beach, California; and Toronto, Ontario. DNV Certification services clients across North America.

S20.20 ANSI/ESD S20.20-1999: Development of an Electrostatic Discharge Control Program covers the requirements necessary to design, establish, implement, and



Dominick Cantore (center), northeast district manager and lead auditor for DNV Certification, addresses ESD Association luncheon attendees at the 2000 EOS/ESD Symposium. John Kinnear (left), Association president, and Ron Gibson (right), ESD Association standards committee chair, presented Cantore with a certificate recognizing the firm as the first north American auditor certified to conduct audits according to the Association's new ESD 2020 Standard.

maintain an ISO 9000 auditable facilities ESD control program to protect electrical or electronic parts, assemblies and equipment susceptible to electrostatic discharge ESD damage from Human Body Model (HBM) discharges greater than or equal to 100 volts.

Although ESD programs have been part of some ISO 9000 audits in the past, the assessment frequently has been cursory and actual judgment of the program has been left to the individual auditor. ANSI/ESD 20.20 provides a formal consistent process standard that can be ISO 9000

audited. It provides a single, auditable ESD standard for OEM's, suppliers, and contractors.

Additional details, including lists of certified registrars, on the new 20.20 certification program will be available shortly from Association headquarters and on the Association web site, www.esda.org. For additional information on DNV Certification programs, contact DNV Certification, Inc., 16340 Park Ten Place, Suite 100, Houston, TX 77084. Phone: 281-721-6818; Fax: 281-721-6903; E-mail: houcertainmarket@dnv.com; Web site: www.dnvcert.com

Symposium highlights

continued from page 1

One for the record books

sisting at the registration booth on Sunday morning," at the height of registration activity.

Registration lines eventually dwindled, tutorial chairs filled, attendees roamed the exhibit hall, the awards breakfast officially opened the Symposium, and technical papers filled the projection screens. When the flurry of activity died down, Koen could easily and accurately state, "Symposium week was bigger than ever with 799 registered attendees and over 600 exhibitor representatives."

More than numbers

While the numbers provide precision in relating the story of this year's Symposium, the content and the overall experience of the attendees are just as much part of the story as are the numbers.

Program included new areas

The record 58 technical papers resulted in nine full technical sessions and one poster session. Technical program chair Steve Voldman points out that the technical program included "new landmark fields, such as ESD in silicon germanium technology, tunneling magnetoresistive sensors (TMR's), mask reticles, and the new ESD S20.20 standard for the first time." Each technical session was fully digital this year for the first time, enhancing and complementing the work of the authors. *Very high quality papers.* New workshop sessions on TLP testing and S20.20 dovetailed with the technical program and the tutorials.

Citing the tutorial program as the "biggest and best ever", tutorial chair Burt Unger put together a series of 25 sessions that included new topics in the areas of RF on-chip protection, TLP testing, and S20.20. One attendee commented, "I learned in one hour what I sat two years in the university to learn."

Attendees queried the authors following the technical sessions, kept tutorial lecturers occupied with questions, and actively participated in the workshops, even the evening ones.

Exhibits busy

Traffic in the exhibit hall was steady and often heavy as attendees went in search of a variety of solutions from device testing services to wrist straps. If the solution couldn't be found among the offerings of the 112 exhibitors in the hall, chances are that it didn't exist.

Reception highlights Association

Even the receptions provided a new twist or two this year. The Tuesday evening ESD Association reception not only provided networking opportunities, but also the chance to *Symposium is making significant impact. . .* about the *Attendee* Association

and how to become more involved in its activities. As they entered the Marina Ballroom, attendees were greeted with an array of informational posters surrounding the entire perimeter. All of the Association's various activities were represented: education, local chapters, Symposium, standards, and more. With pizza or a taco in one hand and drink in the other, attendees made their way from one poster to another, pausing to ask questions and engage in discussion with representatives of each activity. Many also placed a pin in a giant world map indicating the area from which they came. By the close of the evening, the world was well covered with pins.

Next year

The 2000 EOS/ESD Symposium is now history. The planning is now underway for September 9-13, 2001 in Portland, Oregon. Can history repeat itself?

By the numbers

799

total attendees

58

technical papers

582

proceedings pages

62

persons taking the certification exams

52

information posters at the ESDA reception

122.5

hours of technical presentations and education

25

tutorials

5,580

pounds of freight shipped from headquarters to Anaheim

Undisclosed

calories in Wednesday's luncheon desert

7,040

cups of coffee served

214

ESD standards publications purchased

Symposium highlights



Tutorial attendees had plenty of questions for the lecturers.



Signs and more signs point the way.

Thank You!

The 2000 EOS/ESD Symposium was fantastic. Thank you to over 1500 participants - attendees, exhibitors, volunteers. You made it special, you made it big, you made it important.

A special thanks goes to all ESD Association volunteers and staff members and consultants: you made it happen, you made it real, you made all of us look wonderful! Thanks a million and even more!

Koen G. Verhaege
General Chair
2000 EOS/ESD Symposium



Workshop panelists tackle magnetic recording issues.



Attendees test drove CD-ROM based ESD training programs.



A record 58 technical papers highlighted the Symposium.





Registration lines were busy early in the week.



Women's reception provided opportunity to share experiences.



Authors' corners attracted questions and furthered discussion.



Attendees sought products and services on the exhibit floor.



Addison Bain, Ph. D., offered an explanation of the Hindenburg disaster.



ESDA reception offered networking, refreshments, and information on the ESD Association.

Standards meetings focus on S20.20, handbook, future

S20.20, the coming update of the *ESD Handbook*, the fine-tuning of documents, and planning for future work provided the focus for the September 2000 standards meeting series in Anaheim.

New Documents Published

Several recently approved ESD Association standards, standard test methods, standard practices, and technical reports have been published and printed. They are available for purchase from ESD Association headquarters. The newly printed documents are:

ESD SP3.3-2000, *Periodic Verification of Air Ionizers*

ESD STM5.3.1-1999, *Charged Device Model (CDM)—Component Level*

ESD SP10.1-2000, *Automated Handling Equipment*

ESD S11.12-2000, *Volume Resistance Measurement of Static Dissipative Planar Materials*

ESD STM13.1-2000, *Electrical Soldering/Desoldering Hand Tools*

ESD S6.1-1999 (Revised), *Grounding — Recommended Practice*

ESD STM3.1-2000 (Revised), *Ionization*

ESD TR 05-00 *Consideration for Developing ESD Garment Specifications*

ESD TR 06-00 *Static Electricity Hazards of Triboelectrically Charged Garments*

ESD TR 07-00 *Calculation of Uncertainty Associated with Measurement of Electrostatic Discharge (ESD) Current*

ESD TR 08-00 *Socket Device Model (SDM) Tester*

ESD TR 09-00 *Transient Induced Latch-Up (TLU)*

S20.20 Activity

A new program for facility certification and auditing to ANSI/ESD S20.20 was an-



Michael T. Brandt
Editor

nounced at the meeting series and introduced during the EOS/ESD Symposium. In addition, the US Department of Defense has formally adopted S20.20 for use by military agencies. Details on both subjects can be found elsewhere in this issue.

ESD Handbook

The update of the *ESD Handbook* is rapidly nearing completion with publication anticipated in November. The

emphasis of this updated document is to provide guidance and information to assist companies in developing and implementing programs that conform to the new *ANSI/ESD S20.20-1999: ESD Control Program* standard

Working Group Activities

Wrist Straps WG-1 continued its work on a technical report on constant monitors. With some minor fine-tuning and the addition of various figures, the document will be completed.

Ionization WG-3 continued review of a technical report on "Test Methods Providing Greater Sensitivity and Smaller Size than the CPM." The group made numerous changes to the document and expects to complete most of its work by the next meeting series.

Worksurfaces WG-4 worked on a technical report, "A Survey of Static Control Worksurfaces and Grounding Mechanisms." The initial draft is now complete and ready for further review. The group also discussed a possible future technical report on low voltage measurements, but made no decision whether to proceed in this area.

Human Body Model Device Testing WG-5.1 reviewed alternative methods for testing devices with large pin counts. The group is seeking more data in order to finalize a preferred test method. The

group also discussed procedures for measuring the peak current of an HBM discharge waveform.

Machine Model Device Testing WG-5.2 discussed a proposed technical report on reducing the number of pulses per stress level from three to one and reducing the time between pulses from 1 second to 0.5 seconds (consistent with the HBM standard). The group's initial round robin testing revealed data inconsistencies and led the group to an investigation of simulator waveform parameters. The findings indicated a variation in the rise time parameters that are not presently accounted for in the current MM document. Members agreed to perform further investigations to determine whether a rise time requirement should be added to the machine model standard

CDM Device Testing WG-5.3.1 has assigned its members the task of preparing technical white papers for consideration at the group's next meeting. Based on this input, the group will prioritize the subjects in the white papers and suggest action items to resolve any conflicts. The objective is to have an updated document completed by the September 2001 meeting series.

Socket Discharge Model (SDM) Device Testing WG-5.3.2 is developing an industry survey focusing on the need for a second generation SDM tester.

Transient Latch-Up Device Testing WG-5.4 discussed methods of implementing negative bipolar latch-up stressing. The group will begin work to finalize waveform verification and collect additional data for a new standard practice, targeted for completion by June 2001.

Flooring WG-7 discussed differences in the resistance meters used for qualification, acceptance, and periodic testing of floor materials. The group also proposed a definition of a conductive floor material as one having a resistance of $<10^6$

continued on page 11

Standards update

ohms as measured from surface to groundable point and not including a lower limit in the definition.

Footwear WG-9 reviewed comments on its WIP covering shoe grounders.

Handlers WG-10 worked on its draft of a technical report that will cover low voltage (<100 V) issues. The group also held an open meeting with industry representatives to gain additional input in this area.

Packaging WG-11 completed its 5-year review of ANSI/EOESD11.31. The group also worked on changes to its update of the EIA 541 packaging standard under development by the ESD Association.

Loose Fill (Packaging) WG-11.14 is discussing whether to produce the document as a standard practice or a standard test method.

Two Point Resistance (Packaging) WG-11.13 will have initial round robin testing data available for review and analysis by January 1.

US DOD adopts S20.20 standard

The U.S. Department of Defense has formally adopted the ANSI/ESD S20.20 *ESD Control Program* standard for use by all military services within DOD. The adoption means that these agencies may use the document for specification and procurement purposes, but they are not yet required to do so.

Work on S20.20 originated as part of the DOD's specification and standards reform program, which has a goal of replacing military standards with non-government (industry) standards. The ESD Association was contacted to take the lead on developing a document to replace MIL-STD-1686. The Association's standards committee initiated an S20.20 task force, co-chaired by Steve Gerken, US Air Force, and Dave Leeson, Motorola. With significant input from industry, government agencies, and military organiza-

Work Stations WG-53 continued its 5-year review of *ESD ADV 53.1 ESD Protective Work Stations*. The group is expanding the scope of the document to include shelving, cabinets, and drawers.

Clean Rooms WG-55 submitted its initial draft technical report and anticipates completing the document by the February meeting series. The group discussed the preparation of additional technical reports in areas such as garments, grounding, and booties, but made no decision to proceed in any of these areas.

Gloves and Finger Cots WG-15 reviewed results of initial round robin tests of proposed test procedures and found that there were a number of variables that need to be considered when testing of gloves. Further testing and work will concentrate on reducing and controlling these variables.

Hand Tools WG-13 is working on a list of hand tools commonly used in the electronics environment that may present an

ESD hazard. The group will conduct preliminary evaluation of those tools and prepare a work plan based on this evaluation. Part of this effort will include contact with various suppliers of hand tools to avoid developing test procedures that may duplicate those already in existence.

Simulators WG-14.1 reviewed comments on WIP14.0 and began work on simulator specifications and radiated measurement technology. The group will work with outside resources to do some basic waveform measurements using 10 GHz and 15 GHz scopes.

tions, the document was approved by the Association and adopted as an ANSI standard in 1999. Adoption by DOD was in July, 2000.

Although no action has yet been taken to cancel MIL-STD-1686, the military services now have the option to use S20.20. A next step in furthering the use of S20.20 would be implementation of the DOD's "single process initiative," which could suggest that the military agencies look at commercial standards for their acquisition activities.

The S20.20 document is now referenced in the DOD's Assist Internet database, which is part of the Defense Automation and Production Service. The listing can be found at <http://assist.daps.mil>. Click on "Assist-Quick Search" and then enter ANSI-S20.20-99 in the Document ID box or Electrostatic Discharge in the Title box.

Tentative Schedule— February Meeting Series

Doubletree Hotel Portland, Oregon February 2-4, 2001

Friday, February 2

- 8 AM: Wrist Straps WG-1
Ionization WG-3
Device Testing Working Groups WG-5
- 1 PM: Handlers WG-10
Worksurfaces WG-4
- 5:30 PM: Daily Activity Review

Saturday, February 3

- 8 AM: Footwear WG-9
Cleanroom Considerations WG-55
Work Stations WG-53
Device Testing Working Groups WG-5
ESD Handbook
- 1 PM: Packaging WG-11
Flooring WG-7
- 5:30 PM: Daily Activity Review

Sunday, February 4

- 8 AM: Hand Tools WG-13
Simulators WG-14
Gloves WG-15
- 1 PM Standards Committee

Are there two kinds of volts?

Recently my neighbor's son, who is in college, asked me, "Are there two kinds of volts?" His physics teacher had explained that you could measure the voltage of, say, a car battery to 12 V, but there was something called an *electromotive force (EMF)* also measured in volts. He hadn't really understood what this concept meant (the student at least), but were the two volts different?



Niels Jonassen

I assured him that a volt is always a volt and it is one joule per coulomb. However, it is true that there are two different kinds of quantities, both measured in volts: *voltage* (and *voltage difference*) and *electromotive force (EMF)*. Incidentally, the 12 volts of a car battery, strictly speaking, is not a voltage, but the EMF of the battery.

But let's start with the easy concept, voltage and voltage difference.

Voltage is a property of an electric field. The voltage of a given point, P, is the integral of the field strength from that point to ground, i.e.

$$V_P = \int_P^G \mathbf{E} \cdot d\mathbf{a}$$

If the field is caused by the charge on an insulated conductor, then the integral of the field strength from any point in or on the conductor to ground has the same value. That value is called the *voltage* or *potential* of the conductor. This potential is proportional to the charge. (This leads to the concept of capacitance, but that's a different story. Also, an insulator, like a sheet of plastic or a floor covering, can not be characterized by a voltage. A tote box at 3 kV? There's no such thing! But that's also a different story.)

If you integrate the field strength from a point A to a point B, you get the *voltage difference* between the two points

$$V_A - V_B = \int_A^B \mathbf{E} \cdot d\mathbf{a}$$

Now, you may ask: "What about a simple circuit? You have no field strengths there".

Oh, but you do. If you have a current, you have an electric field.

Let's assume you have a wire with a resistance of 10 Ω and it carries a current of 1 A. Then there's a voltage difference of 10 V between the ends of the wire. If the wire has a length of 2 m, then the average field strength inside the wire is

$$E = \frac{10}{2} = 5 \text{ V} \cdot \text{m}^{-1}$$

Also, outside the wire there's an electric field. If you choose a 10 m path from one end of the wire to the other, the average field strength along this path is 1 $\text{V} \cdot \text{m}^{-1}$.

So to sum up:

An electric voltage or voltage difference is always the integral of an electric field strength over a distance.

Now, let's turn to the other volt-quantity, the electromotive force.

A "system" is said to have an electromotive force \mathcal{E} , if a charge q passing the system receives an energy W given by

$$W = \mathcal{E}q$$

or

$$\mathcal{E} = \frac{W}{q}$$

We see the unit for the electromotive force \mathcal{E} is joule/coulomb = volt.

The system may, for instance, be a battery, a power supply, or an inductive coil carrying a changing current. Let's call it a generator. Between the terminals of a generator there will be an electric field and consequently a voltage difference, the output voltage, V_{out} , of the generator.

$$V_{\text{out}} = \frac{R_{\text{ex}}}{R_i + R_{\text{ex}}} \cdot \mathcal{E}$$

V_{out} depends on the electromotive force, \mathcal{E} , on the internal resistance, R_i , of the generator and on the external resistance, R_{ex} , between the electrodes

If the terminals are not connected by a conductive path, then R_{ex} is the resistance of the air between the terminals, which is close enough to being infinitely large, and thus

$$V_{\text{out}} \cong \mathcal{E}$$

In this case the output voltage is numerically equal to the electromotive force, but it should be stressed that the two quantities are not identical.

The electromotive force is a property of the generator; the output voltage is the integral of the field from one terminal to the other.

Having gotten this far, I asked my student friend, if he had understood the explanation.

"I think so", he said. "Just tell me one thing. What's an integral?"

Mr. Static

Texas chapter ropes 'em in

Deep in the heart of Texas, the Texas ESD association views its mission as being a resource for continuing education and information on ESD-related issues and standards.

Organized about six years ago, the chapter has grown to approximately 70 members concentrated in the Austin area, but also from Dallas, Houston, and San Antonio. Periodically, attendees from Mexico pop in at a meeting.

Although its market area is mostly largely semiconductor fab related, the chapter tries to include programs for OEM's and contract manufacturers as well. Regular meetings are complemented with periodic regional ESD tutorials.

Meeting on third Mondays of odd months at Sematech in Austin, the chapter's programs include topics such as control programs and standards, focus-

ing providing continuing education for employees. New topics and varied programs are designed to broaden the scope of membership and participation as well service the information needs of the market area.

Currently in the planning stages is an April RED and regional tutorial program with sessions on ESD basics, standards, and engineering calculations to be followed with the administration of the ESD certification exams for technicians and engineers. Additional details will be found in *Threshold* and the chapter's *Lone Star Spark* newsletter as they become finalized.

For more information about chapter programs or joining the Texas ESD Association, contact Ray Bowman, membership chair, Ph: 512-911-5793, E-mail: r.bowman@motorola.com

ESD Northwest cited as local chapter



The recently formed ESD Northwest chapter was formally recognized by the ESD Association as a local chapter during the Association's annual luncheon in conjunction with the EOS/ESD Symposium. Jerry Dull (right), chairman of ESD Northwest, receives the recognition from John Kinnear, president of the ESD Association. The local chapter serves approximately 80 members in the Pacific Northwest.

More on lightning

Editors Note: the following letter from Bernard Price adds additional comments to the subject of PC's and lightning that appeared in the Letters to the Column in the September/October issue of Threshold.

With regard to the Mr. Static response on lightning phenomena - fusing currents and lightning rod function.

It should be noted that fusing current analysis for 16 gauge copper wire exposed to an order of magnitude greater current stroke that referenced in the article will in fact pass the stroke without melting - as correctly mentioned due to the short duration of the current stroke.

The answer with regard to lightning rod function is along the right track. One has to think what is happening as you build this ionized path between the earth and thunder cloud? You have created a low impedance path sufficient for rapid charge transfer or in other words a lightning strike.

Leader formation

What is essentially described is the "leader" formation which occurs at the cloud base and from preferential points (sharp/or high) on the ground. This occurs a fraction of the speed of light as leaders branch and eventually meet creating a lightning strike.

Watch a storm closely and you can see the multiple return strokes pass through the fixed leader channel along with the uncompleted branches upward for ground-to-cloud or downward for cloud-to-ground. Standing in the leader path is potentially lethal with currents on the order of 200 amps or at best providing the ominous precursory sensation noted

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Professional certification exams attract 62

Administered on the Friday following the EOS/ESD Symposium, the professional certification exams for ESDC engineer and ESDC technician attracted 62 test takers. Many also attended the pre-exam tutorials on Sunday, Monday, and Thursday to help them prepare to take the open-book exam. Loaded with references and computers, the candidates sharpened their pencils, scratched their heads, did their calculations, and searched their references during the all-day two-part examination session.



Association selects directors, officers

The ESD Association, has selected new board members and officers for 2001.

Elected to the board of directors for three-year terms were Charvaka Duvvury, Texas Instruments, Plano, TX; Tom Diep, Texas Instruments, Dallas, TX; Joe Bernier, Intersil Corporation, Melbourne, FL; and Steven Voldman, IBM Microelectronics, Essex Junction, VT. Mark Kelly, Delphi Delco Electronics Systems, Kokomo, IN, was appointed to the board.

The board of directors also re-elected its officers. They are president, John Kinneer, Jr., IBM, Poughkeepsie, NY; senior vice president, Stephen A. Halperin, SHA/Prostat, Bensenville, IL; and vice president, Ed Weggeland, Richmond Technology, Redlands, CA. Sue Ohrman, VPI LLC, Kirkland, WA was re-appointed secretary.

Letters to the editor

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More on lightning

by survivors. The rod and its ground connection function as a preferential path for leader formation and subsequent strike current. Lightning protection system don't preclude lightning strikes. They simply increase the likelihood that a leader will form away from things that burn, explode, or otherwise die when subject to that kind of energy.

Bernard Price
Alliant TechSystems

Mr. Static replies

In the article, I pointed out the essential differences of the two (possible)

modes of action of a lightning rod. I didn't want (for volume reasons) to go into the well-known principles for leader formation etc. All this is explained in the reference given. Mr. Price seems to exclude the neutralizing effect of a lightning rod. The scientists at the Langmuir Lab in New Mexico actually managed to reverse the polarity of a thundercloud by a heavily ionized air blast, so maybe the lightning rod sometimes in a silent way also prevents a stroke.

Mr. Static

Institutional Listings

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