The Product Safety Engineering Newsletter

Vol. 4, No. 1 March 2008

What's Inside

President's Message

Now that 2008 has arrived, this is the Product Safety Engineering Society's fifth year as an IEEE Society. It has been interesting and challenging for those who are serving on the Board of Directors and committees that are trying to keep the society moving forward. Since our start, we have more than doubled our society membership and are one of the few societies that are growing. We are also bringing new members into the IEEE, which makes us even more unique. We do not have as many members that we think we should have, but we are continuing to increase membership.

Last year was a pivotal year for the society. In the past, getting people to present papers at the symposium was difficult. It required a lot of phone calls on the part of those responsible for the technical content. Then last year, people started to offer to present instead of being called and asked to present. We expect that trend to continue and expect the 2008 Symposium to be bigger and better.

As a society one of the items we need to have is an active Technical Activities Committee (TAC). The TAC provides needed resources such as reviewing symposium papers and Journal papers (if we ever have a journal). They will also review the questions for iNARTE to insure they have a good pool of questions to certify safety engineers. So we need to get our TAC put together with volunteers to assist. Please consider participating in one of the TAC's. Visit our TAC page for contact info. After visiting the page if you have an idea for another TAC, please share your idea with Jack Burns at jburns@ieee.org.

Sometimes I wonder if anyone is out there.

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The
Product
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Newsletter

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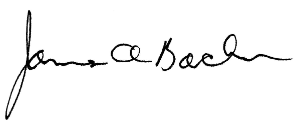
Our Newsletter Editor has only received one email, so we do not know what you think of the newsletter and wonder if anyone is reading it. Please let us know what you like or dislike about what we are doing. We would like to hear your thoughts on the newsletter and the Society in general.

I do expect 2008 to be an even better year for the society, but we need your help to accomplish it. Please promote membership in the society and find ways you can help us continue the forward movement of the society. Be it by assisting a TAC, starting a chapter, promoting the society, or a vendor to be at the symposium.



James A. Bacher
President IEEE PSES

Tip: ***Best way to get your boss to approve your trip to the 2008 Symposium on Compliance Engineering is to submit a paper that gets accepted for the symposium! Or volunteer and tell him you have to be there!***

Seeking Nominations for IEEE Medals and Recognitions

The IEEE Awards Board is seeking nominations for IEEE Medals and Recognitions and encourages the use of its online Potential Nominee Form. This form allows a preliminary review of a nominee by the selection committee and an opportunity to obtain feedback prior to submitting an official nomination form. The Potential Nominee Form is available on the IEEE Awards Web Page at:

http://www.ieee.org/portal/pages/about/awards/noms/potnomform.html

The deadline for submission of an official nomination form for any of the IEEE Medals and Recognitions is 1 July 2008. For questions concerning the Potential Nominee Form, please contact awards@ieee.org.

Chapter Safety Probes

To see current chapter information please go to the chapter page at:
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News and Notes

Role of Warnings and Instructions course is scheduled

The University of Wisconsin College of Engineering Department of Engineering Professional Development will offer its well-regarded course on warnings and instructions April 22–24, 2008 at the university's Madison, WI campus. In addition to general course materials, participants in the three-day course will receive copies of the ANSI Z535.4 standard for product safety signs and labels and the ANSI Z535.6 standard for safety information in product manuals. For more information, visit http://epd.engr.wisc.edu/webJ045 or call Program Director Dick Moll at 800-462-0876. (See the December 2006 issue of *PSEN* for an article about this course.)

New PSES Jobs Web Page

PSES has a new page on our web site for employers and job seeks at http://www.ieee-pses.org/jobs.html. Employers may post jobs seeking regulatory or compliance-related personnel free of charge. Job postings will remain on this web site for a period of 6 months but may be removed earlier by request of the employer. We currently have over half a dozen postings.

Society members who are seeking jobs may list a description of the position they are seeking free of charge. A resume in PDF format may also be posted if desired. The listing will remain on this web site for 6 months, but the owner may submit a request to renew the listing every six months, indefinitely. It may be removed earlier by request.

See http://www.ieee-pses.org/jobs.html for posting policy and how to submit requests.

2008 PSES Symposium Updates

The 2008 PSES Symposium will be held at the Austin Marriott North, http://www.marriott.com/hotels/travel/ausno-austin-marriott-north/, in Austin, TX, from October 20-22, 2008. For those who register for the symposium, UL is offering a 25% discount for two of their follow-on seminars following the symposium. The first seminar is the UL HBSE Seminar to be held from October 23 & 24, 2008. The second seminar offering is the UL Medical 60601 to be held on October 23, 2008. Bothseminars will be held at the same hotel as the symposium. Details will be posted on the UL University web site in the near future.

The 2008 PSES Call for Papers has been issued, http://ewh.ieee.org/soc/pses/symposium/CFP2008.pdf. The deadline for intent to present is April 29, 2008. Send all intents to Technical Program Co-chair, Bob Griffin, bobgriff@us.ibm.com. To be considered for the Special Technical Program, contact Rich Nute, richn@ieee.org.

iNARTE is planning on having a workshop during the symposium. An exam is planned to be given after the symposium. Details will be available at the iNARTE website,
http://www.narte.org/

For the latest news and activities on the 2008 PSES Symposium, visit http://ewh.ieee.org/soc/pses/symposium/index.html

Monitoring the Integrity of the Safety Ground by a Novel Electronic Circuit

by Nosh K. Medora, S.M., P.E. and Alexander Kusko, Sc.D., P.E.

Equipment ground for appliances

The human body is susceptible to electric shock and consequently electrical equipment, tools, and appliances need to be adequately protected against an electrocution hazard. One of the principal means of protection is to have a safety ground wire connected to a known earth ground. Electrical equipment is grounded for several reasons:

1. To prevent electric shock if a fault occurs in the equipment;
2. To provide a path for fault current to operate a protection element such as a fuse or a circuit breaker;
3. To prevent the buildup of electrostatic charge that can cause shock and error in computers and data processing equipment;
4. To prevent the buildup of electrostatic charge that can cause a spark and explosion in a hazardous environment.

Typically the grounding is accomplished by a green (North America) safety wire in the cord, or by a separate grounding jumper or by the metallic conduit that carries the wires to the equipment. The 2008 *National Electrical Code* (*NEC*)[1] provides specific requirements for grounding in Article 250.

Ineffective ground—a safety hazard

The grounding of equipment can be ineffective for a number of reasons. These include but are not limited to the following:

1. The green safety wire is disconnected at the equipment.
2. A two-wire cord is used with no green safety wire.
3. The three-prong plug is plugged into a two-slot receptacle, using an adapter. The grounding pigtail of the adapter is not connected.
4. The ground socket of the receptacle is not grounded within the receptacle.
5. The green safety wire is broken in the cord.
6. The ground connection at the circuit breaker panel is intermittent or has a poor connection.

The security of the grounding can be checked by connecting an ohmmeter between the equipment and a known ground, such as a metal electrical conduit. However, this approach requires a nearby known ground, and furthermore, does not provide a real-time, continuous monitoring of the status of the ground connection.

An ineffective safety ground can further lead to a fault condition possibly resulting in an electrocution hazard. The fault condition can be due to a number of different reasons, such as:

1. Frayed or damaged insulation within the equipment, resulting in exposed energized conductors making contact with a metal enclosure.
2. The ground wire connected to the metal enclosure of the appliance is broken and the frayed conductors make contact with the "hot" terminal of the ac supply, resulting in energizing the metal enclosure.
3. The presence of a conductive foreign object such an unsecured metal screw bridging the gap between the hot terminal and the metal enclosure.
4. Conductive contamination on an insulating member creates a conduction path from the "hot" terminal to the metal enclosure. Fig. 1 shows the increase in leakage current due to the buildup of conductive contamination. Fig. 2 shows the buildup of conductive contamination between the hot and the ground terminals on a terminal strip used in a 115 Vac filter network.

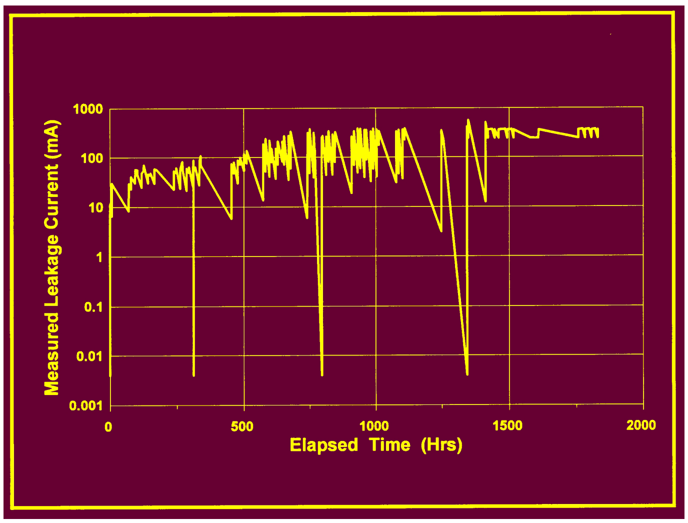

Fig. 1. Build up of conductive contamination as a function of time on an insulating support at 100 Vdc due to exposure to salt spray, which results in an increase in leakage current - electrocution hazard.[1]

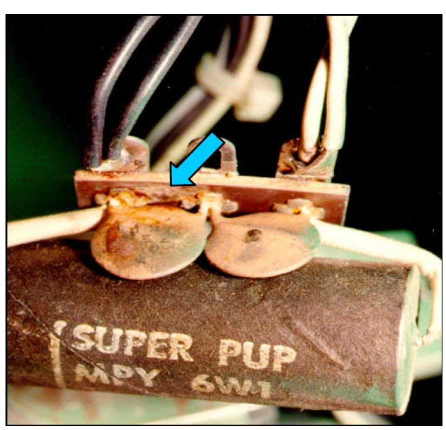

Fig. 2. Arrow shows build up of conductive contamination on a three-terminal, lug-type terminal strip used in a 115 Vac filter network, in a shipyard environment. The two outer lugs were connected to the hot and neutral wires. The center terminal was bolted to the metal housing.[2]

Continued on Page 8

Consequently, when an electric tool or appliance loses its safety ground connection (due to the ground pin being cut or due to the use of a three-to-two adapter), and an internal fault occurs, the metal housing may become electrically "hot" resulting in a safety hazard.

Case study—electrocution due to foreign object between hot terminal and metallic housing in the absence of ground

The authors have been involved in numerous electrocution cases. In many of these electrocution cases, two conditions were fulfilled: 1) the ground terminal was inadvertently or purposely broken or disconnected; and 2) subsequently the metallic housing of the subject equipment was accidentally connected to the hot terminal. This could be by: a) electrically conductive contamination; b) a metallic foreign object; or c) by frayed or damaged insulation within the equipment. This would result in exposed energized conductors making contact with the metal enclosure. A case study is described below involving an electrocution using an electric drill connected to an extension cord.

This incident involved a 120 Vac electric drill with three-wire cord, connected to a three-wire extension cord. The subject extension cord was plugged into a three terminal wall outlet. The investigation revealed that an individual was using the subject electric drill to drill a hole in his vehicle to install a CB antenna. The vehicle was parked in his front yard. A few hours prior to the incident, there had been a severe rain storm. Witnesses said that they observed the individual standing in a grassy area in a pool of water in his front yard while attempting to perform the drilling operation. The individual was found lying on the ground and was rushed to the hospital. The coroner's report stated death by electrocution. Fig. 3 shows an exemplar electrical drill. Fig. 4 shows an exemplar three-wire extension cord.

Fig. 3. Exemplar electric drill. The original molded three-wire, 120 Vac plug has been replaced by a different plug. On the right is a sheet metal screw similar to one found in the subject drill.

A subsequent investigation revealed that the subject three-wire extension cord had the ground prong deliberately cut off, resulting in the metal enclosure of the drill being ungrounded. Further investigation revealed that the subject electric drill had been purchased a week ago

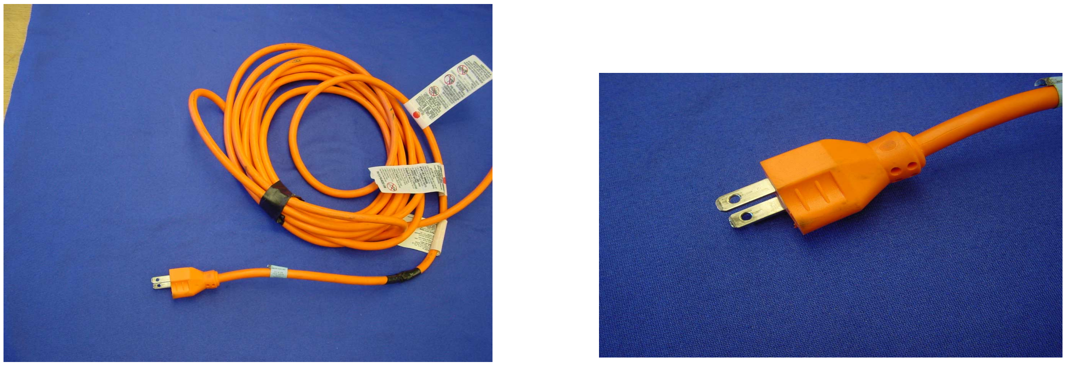

Fig. 4. Exemplar 120 Vac, three-wire extension cord with the ground prong cut off.

at a yard sale. Visual inspection of the drill indicated that the subject drill had been disassembled and re-assembled. When the subject drill was physically shaken, an audible sound was heard, as of a foreign metallic object. X-ray and subsequent disassembly revealed an unsecured sheet metal screw within the subject drill.

It appeared that at the time of the electrocution, this unsecured metal screw was bridging the gap between the hot terminal and the metal enclosure. Due to the absence of the ground pin, the enclosure was now at 120 Vac with respect to earth ground and consequently the individual, who was standing in a grassy area in a pool of water, was electrocuted.

Novel grounding detector circuit

It is the authors' understanding that currently there is no feasible circuit that will automatically determine if the housing of an appliance is grounded, floating, or electrically hot without using a known reference potential terminal.

The authors here present a Grounding Detector (GDT) circuit that could be used in conjunction with a Ground Fault Circuit Interrupter (GFCI). The advantage of the GDT over the GFCI is because the former monitors a voltage and the latter monitors a current. The GDT continuously monitors the voltage on the metal housing of the appliance. If the metal housing becomes electrically "hot," the GDT quickly detects this hazardous condition and takes corrective action, disconnecting the 120 Vac power from the hazardous appliance, and activating an audible alarm.

It should be noted that in order to trip, a GFCI requires that a grounding connection be present upstream of the GFCI. Furthermore, the GFCI detects an unbalanced current and consequently will take no corrective action until a human comes in physical contact with the hazardous appliance resulting in the flow of ground fault current.

Information for this GDT circuit has been extracted from U.S. Patent 5,065,104[3] which has been issued to the authors for this novel circuit and from the authors' technical paper published in 2006 by the IEEE Product Safety Engineering Society (PSES).[4] Mr. Medora also demonstrated the GDT circuit at the 2006 IEEE PSES Conference. The basic principle of this patent, to use an isolated ground in conjunction with a neon lamp optoisolator as a means for

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detection of the hot wire, was determined by Mr. Medora when he was about fifteen years old and was researching in his personal laboratory at home.

Prior art circuits

Prior to the issue of this patent, the authors researched at least eighteen U.S. and foreign patents to determine the approaches followed in the prior art technology for establishing and monitoring the status of the ground connection. It was determined that the prior art circuits required at least one pre-selected terminal to be always at a known reference potential.

The prior art circuits assume that this "reference" terminal is always at a fixed known potential. As an example, a prior art circuit may use the left terminal of the ac outlet (neutral) as the reference, and assume that this terminal is always at approximately zero volts with respect to earth ground. A problem arises if the ground prong is missing, or a two-wire cord is used, and the plug inserted. In this case, which wire is neutral depends on the position of the plug in the receptacle. Polarized plugs may help, but the authors are familiar with several instances where the wider polarized pin has been deliberately trimmed and then the plug forced into the receptacle. Fig. 5 shows a typical socket tester used to verify the integrity of the three terminals of a 120 Vac outlet. These testers use the ac line as a reference.

Fig. 5. Socket testers are typically used to verify the integrity of the power ground. Since these testers use the ac line as a reference, the socket tester results can be questionable and may even constitute a safety hazard.

Principle of operation

The GDT provides a technique for the detection of an ineffective ground in the equipment. The principle of operation of the GDT is based on the fact that the GDT circuit provides a reference ground potential independent of a normally grounded conductor. The ac line is not used to provide a reference, since which wire is hot depends on the position of the ac plug in the receptacle.

Once the reference ground has been established, a detector circuit senses the potential on the ac lines for determining which is the live wire of a two- or three-wire cord independently of the location of the live, neutral and ground wires in the power system. The circuit may visually indicate all existing states of the equipment ground, including ground OK, ground open and ground-to-line fault condition. The circuit may also include sensing a preexisting fault condition before applying ac power to the equipment being monitored. If the fault condition exists, the GDT circuit prevents application of utility power to the equipment.

Theory of operation

Fig. 6 shows a combined block-schematic circuit diagram of the GDT circuit. The three-wire equipment cord includes a black hot wire, a white neutral wire and a green ground safety wire. For illustration, the protected equipment is a single-phase electric motor M. Utility power is applied to the motor windings through initially open contacts of the contactor connected to ground status detector circuit. The green ground wire is directly connected to the enclosure of the equipment. A sensing lead is also connected from the equipment enclosure to one end of the resistor in the star network.

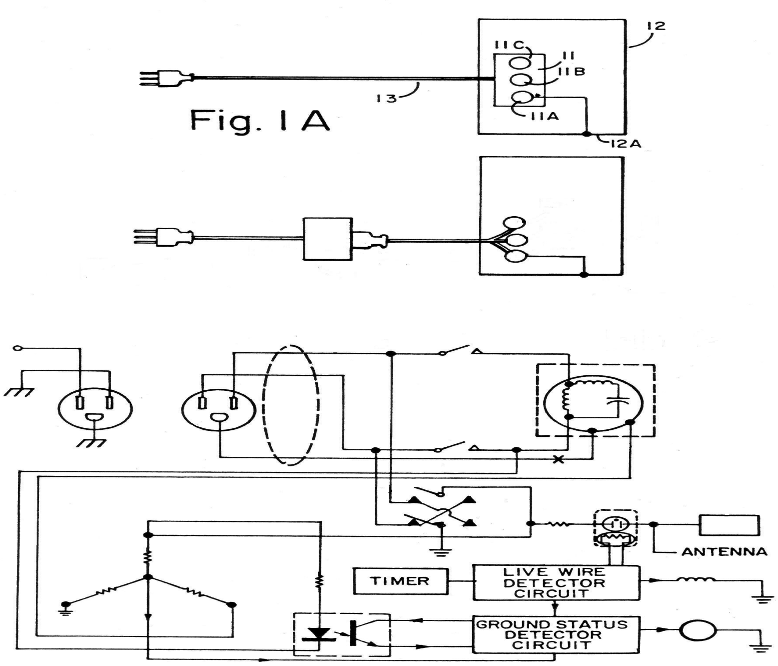

Fig. 6. Block diagram illustrating the principle and theory of operation of the GDT.

A double-pole, double-throw polarity reversing relay alternatively connects each terminal to one electrode of the neon lamp N of the neon lamp-cadmium sulfide (CdS) optoisolator assembly. The other electrode of the neon lamp is connected to a reference ground plate.

The metal reference ground plate may be a copper or aluminum rectangular plate contoured to fit the enclosure. The relay coil is powered by the live wire detection circuit. The neon lamp of the neon lamp-CdS optoisolator is optically coupled to a cadmium sulfide CdS detector connected to the live wire detector circuit, whose output is connected to a relay coil for polarity switching if necessary.

When power is applied to the grounding detector circuit by inserting the plug into the receptacle, the relay coil is not energized, and so the contact is made to one ac terminal assumed to be the hot terminal. This hot wire is thus effectively connected to one electrode of the neon lamp-CdS optoisolator. The other electrode of the neon lamp-CdS assembly is connected to the reference ground plate and antenna to create an artificial ground reference potential at

Continued on Page 12

wire by an isolated capacitance effect. This ignites the neon lamp to provide a signal optically coupled to the live wire detector circuit. This optoisolator provides high electrical isolation while operating at very low current levels of the order of a fraction of a µA.

For an isolated conductive square plate with each side = 10 cm, the current in the neon of the neon lamp-CdS optoisolator is approximately 0.20 µA. This is an extremely low value of current and specific circuit topologies and a high sensitivity neon lamp optoisolator have to be used to detect this current rapidly and accurately.

The live wire detector circuit includes a memory element for holding the status of the relay. If however the assumed hot terminal is the neutral terminal, no signal would be received since the neutral wire would be at approximately zero volts or ground potential and thereby provide no potential difference across the electrodes of the neon lamp, of the neon lamp-CdS assembly. The neon lamp would then remain extinguished and not provide a signal. The absence of a signal activates a timer IC and enables live wire detector circuit to energize the relay coil and the DPDT configuration now connects the neon lamp to the other terminal, illuminating it and sending a control signal to the live wire detector circuit to hold the status of the relay. The process just described is repeated until a signal is received from the CdS detector and the live terminal thus identified.

Once the hot terminal is identified, the voltage at the star point is used to determine the voltage on the metal housing. The star-point resistors are specifically selected to allow the GDT to make a determination as to whether the metal housing is connected to earth ground, or is floating, or is connected to the hot terminal. This determination is made by measuring the voltage at the junction point of resistors forming the star or Y network.

The LED optoisolator may be used to detect a pre-existing fault condition—if safety ground is ok and a line-to-ground fault is present. This would result in a large fault current at the moment of contact closure. The circuit may be designed to prevent the main contactor from closing and applying ac power if the fault condition is present. Note that ground symbols in the lower portion of Fig. 6 denote dc power supply ground; this is not connected to the utility ground.

The line-to-ground fault or ground open condition may be indicated by illuminating a red LED (not shown in Fig. 6), and an effective ground may be indicated by illuminating a green LED (not shown in Fig. 6). If there is no pre-existing fault in the equipment, the ground status detector activates the main contactor, which closes the main contacts and thereby applies ac power to the equipment.

The status of the equipment ground is continuously monitored, and any change is indicated by the yellow and red/green LEDs. If now the ground becomes ineffective or a fault occurs in the load equipment, the new status is immediately detected and corrective action taken. The main contactor is de-energized, opening its contacts and removing ac power from the appliance, and further illuminating the red LED. The circuit is now latched in the off-state until manually reset by the operator. Fig. 7 shows the prototype GDT circuit.

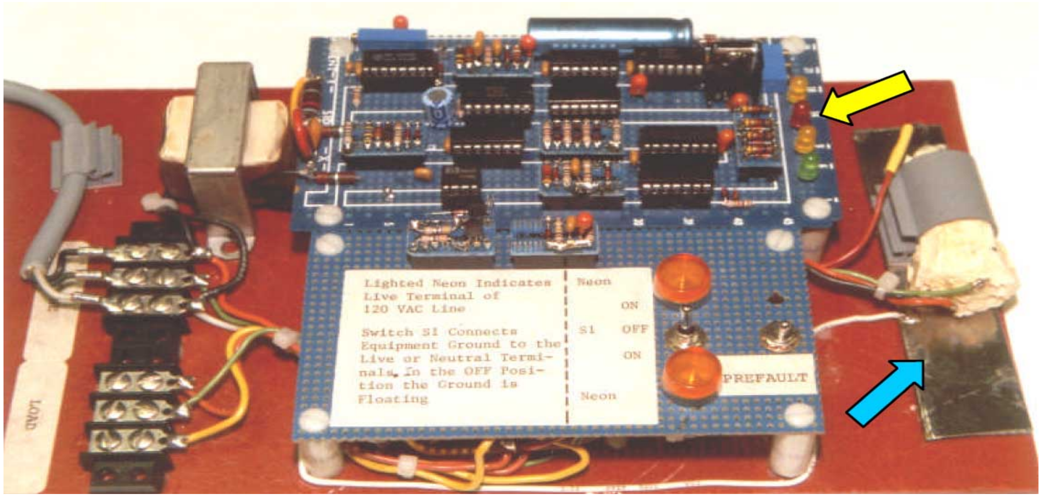

Fig. 7. Prototype GDT Circuit. Blue arrow shows the isolated capacitance plate. Yellow arrow shows the three status LEDs. This version was powered by a small transformer.

Two versions of the GDT circuit

This article briefly summarizes the principle of operation and key features of the GDT circuit. Several versions of the GDT were designed and constructed, two of which are presented here.

Version 1 is an earlier model, with two LEDs—a yellow LED and a red/green bi-color LED. This version also includes an electromechanical contactor whose contacts are connected to the ac outlet mounted on the face plate. When the GDT circuit has determined that the ground is intact and effective, the red/green ground status LED is green and the ac outlet is energized. The yellow LED is energized when the circuit is in the process of detecting the live wire.

The GDT Version 2, is an enhanced version of GDT 1, and was specifically designed to be a low cost, high speed indicating unit, with a bi-color Red/Green LED to indicate the status of the equipment ground. The typical detection time for detecting the “hot” wire is approximately 1-1.5 s. This low-cost unit has no power contactor. However, if required, a power contactor can be readily included, at additional cost. Fig. 8 shows the GDT Version 2.

The operating time required to make the initial determination as to which is the hot terminal is dependant on several variables including, but not limited to the following: 1) striking voltage of the neon lamp optoisolator; 2) optical efficiency of the neon lamp; 3) sensitivity of the CdS photocell; 4) magnitude of the input ac voltage; 5) frequency of the input voltage; 6) pre-set threshold at which the circuit determines that the “hot” terminal has been correctly identified; 7) placement of the isolated ground plate; and 8) available area of the isolated ground plate.

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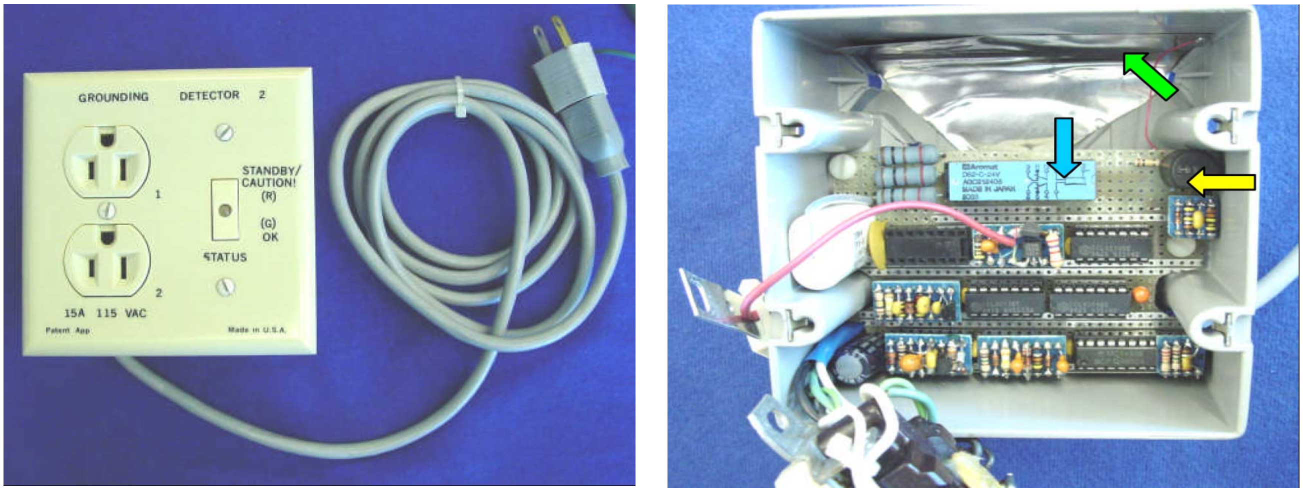

Fig. 8. Left, Grounding Detector Version 2 circuit installed in a non-metallic outlet box with the bi-color red/green ground status LED. Right, yellow arrow indicates the neon lamp CdS optoisolator; blue arrow shows the polarity switching relay; green arrow shows the metal plate.

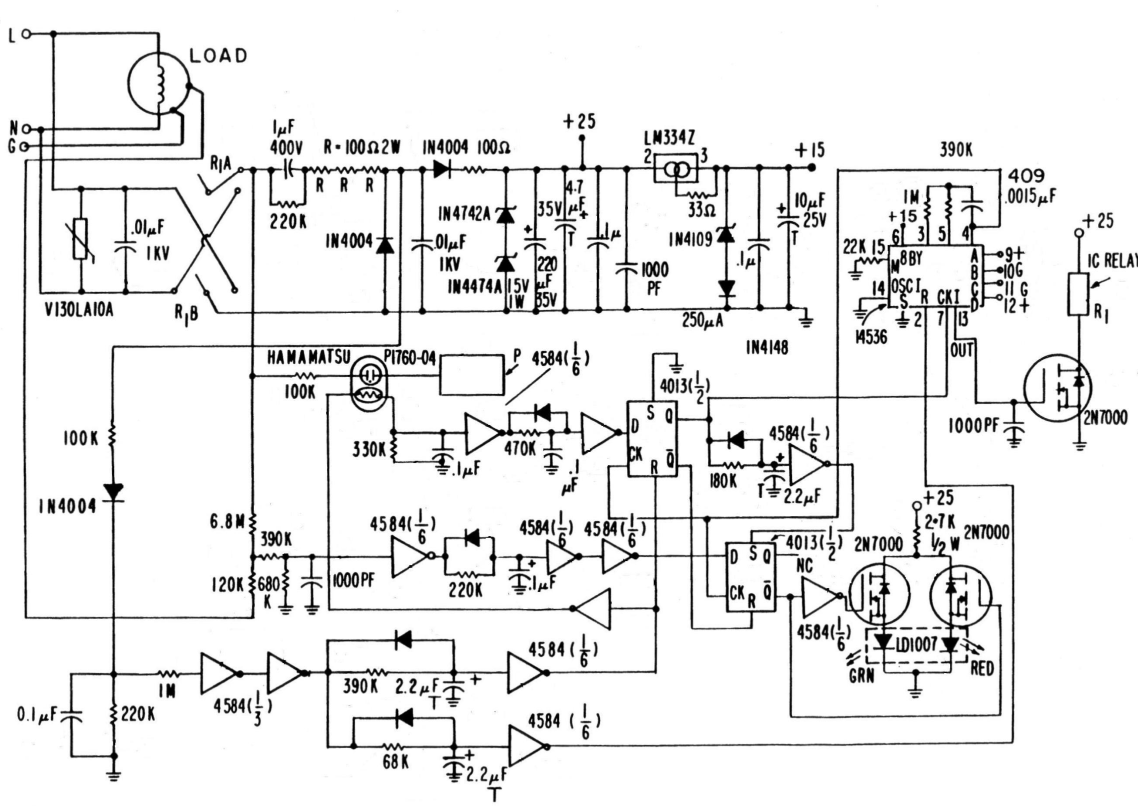

Fig. 9. Schematic diagram of Grounding Detector Version 2.

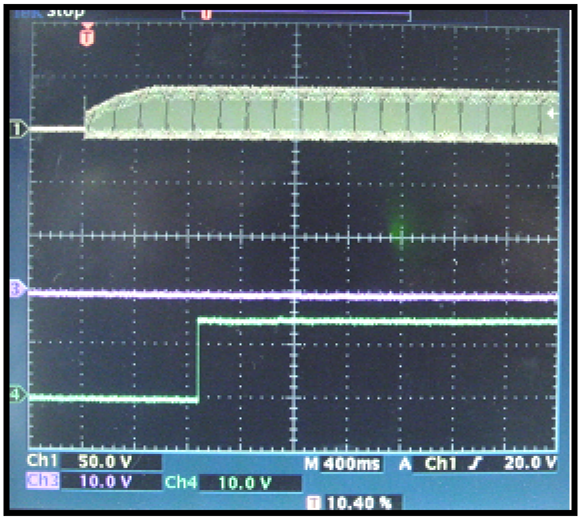

Fig. 10. Selected oscilloscope waveforms of the Grounding Detector Version 2.
Top Trace: Voltage at input terminal of the first 100 ˜, 2 W resistor.
Middle Trace: Voltage to Gate of FET controlling relay coil. Depending on the polarity of the input ac, the detection circuit may turn the FET on to energize the relay coil which switches the polarity of the input ac, to permit detection of the "hot" terminal.
Bottom Trace: Output of second inverter connected to neon lamp-CdS optoisolator. When the "hot" terminal is detected, the output goes high.

Fig, 8 also shows the DPDT relay, Integrated Circuits (ICs) and other components used in the GDT Version 2. The four CMOS ICs are towards the bottom right. Fig. 9 presents the schematic diagram and Fig 10 presents selected waveforms of the GDT, Version 2.

Proposed applications

The GDT circuitry shown here may be incorporated into existing electrical equipment or be factory installed into new equipment. It may be used for the following:

1. As a permanently installed monitoring unit for critical applications such as medical equipment, hospital beds, mobile homes etc.
2. In an outlet strip for computers, appliances and other electrical/electronic equipment.
3. In an outlet assembly at the end of a conventional extension cord.
4. As a plug-in test detector for receptacles, wall outlets and extension cords.
5. As a plug-in detector for industrial workplace grounding to check the presence of a positive ground when handling equipment that is sensitive to static electricity.
6. The GDT circuit may be embodied in single-phase three-wire, 240/120-V circuits, and also in 240 Vac and 480 Vac, three-phase, three-wire and four-wire circuits.

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Conclusions

This article leads to the following conclusions:

1. A grounded conductor may be identified by Article 200.6 of the 2008 *National Electrical Code* (*NEC*).[5] However, the most common identification is the following:
    a. Wire sized 6 AWG or smaller: insulation continuous white or gray outer finish or by three continuous white stripes on other than green insulation along the entire length.
    b. Wire size larger than 6 AWG: same as above plus, a distinctive white or gray marking at the terminations, which encircle the conductor or insulation.
2. A grounding conductor may be identified by Article 250.119 of the NEC 2008. However, the most common identification is the following:
    a. Wire size 6 AWG or smaller: bare, covered, or insulated. Covered or insulated conductors shall have a continuous outer finish that is either green or green with one or more yellow stripes.
    b. Wire size larger than 6 AWG: Insulated or covered conductor identified at each end and where accessible by stripping the covering or insulation where exposed, coloring the insulation or covering green at the terminations, marking the insulation or covering with green tape or green labels at the termination.
3. A novel Grounding Detector circuit is presented which has a number of advantages:
    a. It continuously monitors the status of the equipment ground, whether ground OK or ground open or ground connected to hot terminal, and provides a visual and/or audible indication of a fault condition.
    b. It needs no external reference potential because the reference ground plate provides an internal reference ground potential.
    c. The device provides for non-polarized operation. The circuitry accurately identifies the live terminal in a two-wire or three-wire cord, independently of the potential of the live, neutral and green safety wires. The circuitry is thus polarity independent, an important feature, because the identity of the black and white wires as carrying live and neutral potentials, respectively, may not be correct when the power cord reaches the equipment.
    d. The circuit can include a power contactor to disconnect ac power from the equipment in the event the ground is open or the ground is connected to the hot terminal.
    e. This monitoring circuit may be incorporated into an ac outlet strip, or equipment, or placed at the end of an extension cord.
    f. This circuit may also be used in conjunction with a GFCI to provide a higher level of protection.
    g. This GDT circuit is, in some respects, superior to a GFCI. The advantage of the GDT over the conventional GFCI is that the former monitors a voltage, and the latter (GFCI) monitors a current. The GDT continuously monitors the voltage on the exposed metal housing of the electric appliance. If the metal housing becomes electrically hot, (safety ground is cut and an internal fault has occurred), the GDT circuit immediately detects this hazardous condition and takes corrective action—it disconnects the 120 V ac power from the hazardous appliance, and visually and audibly indicates an alarm condition. On the other hand a GFCI would take

no corrective action until a human being came in physical contact with the failed equipment and the resulting circuit caused a flow of ground fault current.

h. The GDT may be used to check the presence of a positive ground when handling equipment that is sensitive to static electricity.

i. The GDT circuit may be embodied in single-phase three-wire, 240/120-V circuits, and also in 240 Vac and 480 Vac, three-phase, three-wire and four-wire circuits.

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Novelty Shock Pens — Harmless Toy or Injurious Weapon? Only a Proper Design Analysis Can Tell

by Michael S. Morse, Ph.D. and Greg Tolchinsky

I. Introduction

In the last half of the 20th century Charles F. Dalziel compiled data on the physiological effect of current flow in the human body. His work has been the cornerstone for anticipating the cause and effect relationship between electrical contact and associated injury, and has largely come to define what might best be called the "Traditional Model" for electrical injury.(1,2,3) In the last fifteen years a much broader understanding of electrical injury has evolved. As research began to uncover deviations from the "Traditional Model", the "Modern Model" has evolved to acknowledge the existence of electrical injury by "pathway-independent mechanisms" and injury where the magnitude of the injury is disproportionate to the magnitude of the shock.(4)

To avoid negligence as seen by the law, product designers must evolve with the evolving state of science to incorporate the "Modern Model" of electrical injury into their analysis when assessing the risk of electrical injury associated with any product.

II. Traditional model

The "Traditional Model" of electrical injury assumes that the effects of an electric shock on the body can be predicted by analyzing the current pathway, current level and energy imparted during an electrical contact. For the Traditional Model analysis, the theoretical current pathway, can be approximated as the shortest path between the entry and exit points of the current. Although the absolute pathway is unknown, it is known that the current will enter the body through the point(s) of contact of higher electrical potential and exit through point(s) of lower potential on its return to ground. The current magnitude is determined by the simple ohm's law calculation which uses the voltage differential between entry and exit points along with an estimate of pathway resistance.(5,6,7) Further, per the Traditional Model, it is accepted that current density and energy dissipation may have localized impact.

Table 1 lists the Tradition Model anticipated physiological response as a function of current level. This often reprinted table is based on the established Traditional Model view that there are three prongs that define and limit electrical injury:

1. Energy based injuries from resistive heating: Energy dissipated locally along the current pathway causes resistive heating of tissues through which the current passes. The energy imparted locally can be calculated as Energy = I^2RT where I is the current flow through localized resistance R for duration of the shock, T. When local temperature rise reaches a critical point, tissue damage occurs.(8) Any organ system in the pathway of the current flow would be susceptible to such injury. As the parameters of the shock increase, so does the area that would be at risk of thermal damage.

2. Ventricular fibrillation: Electrically induced ventricular fibrillation is more of an interruption of physiological processes than an injury and is a somewhat random process that results when the pacing of the heart is impacted by the flow of current. Traditionally the threshold is thought to have been approximately 50mA for a hand to hand contact.(1,2,3) Although the energy imparted during brief contacts is often below the threshold for thermal injury, fibrillation of the heart may still be induced, resulting in certain death absent medical intervention and defibrillation.(1,9)

3. Respiratory arrest: When the electrical current pathway traverses the respiratory muscles (diaphragm and intercostals) or those nerves that innervate the respiratory muscles, the impacted muscles can be stimulated to tetanic contraction such that voluntary respiration ceases and death by asphyxiation will ensue absent cessation of the electrical current. Electrical current can also impact the respiratory center of the brain, causing respiratory arrest. Medical triage for electric shock requires immediately assessing if there has been respiratory impact and providing proper treatment until breathing can be restored.(7,10,11)

Table 1.
Traditional model: Effects of electric current on the human body

Response	Average Minimum AC Current level
Sensation - tingling (first perception)	1 Milliamp
Painful shock but no loss of muscle control	9 milliamps
(Can't) Let go	14 milliamps for males (10 milliamps for females)
Painful muscle contraction/ difficulty breathing	23 milliamps
Ventricular Fibrillation	50 milliamps (hand to hand contact)
Myocardial sustained contraction	Greater than 1 ampere (>1000 milliamps)
Burns (Thermal Injury)	Greater than 1 ampere (> 1000 milliamps)
Typical Household Circuit Breaker	20 Amperes

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Beyond the three prongs of injury described above, it was generally believed (for most of the history of generated electrical energy) that no other form of electrical injury existed. In fact, the overwhelming majority of electrical injuries are still best explained by the Traditional Model.

III. Modern model

While the majority of electrical injuries can be explained by the Traditional Model, research has uncovered many anomalous responses that fall outside the scope of that model. It is those anomalies that form the backbone of the Modern Model of electrical injury. The Modern Model recognizes the existence of "pathway-independent" mechanisms and also recognizes that the human response to an electrical contact can be disproportionate to the electric shock parameters. Although theories exist, researchers are as of yet unable to isolate the mechanism(s) responsible for these non-traditional responses but there is little doubt that there is a causal link between the electrical contact and the ensuing symptoms. Even without knowing the mechanism, it has been quite possible to statistically establish the cause and effect relationship.

From a practical perspective, one must accept that humans are vastly more complex than human-engineered technology, and as such it is likely that our diagnostic technology has simply not reached the state where we can image all of the mechanisms that cause the injuries that are associated with the electrical contacts.[4,12,13,14,15,16]

<u>Diffuse electrical injury</u>

A somewhat rare class of electrical injury response that cannot be described within the bounds of the Traditional Model has been termed by these researchers as "Diffuse Electrical Injury" or "DEI."[4,12] Others have documented almost identical post-electrical contact symptomatology which is now called by a variety of names throughout the literature.[13,14,15] For our discussion, we will simply use DEI to refer to any electrical injury sharing a statistically common symptomatology that is both disproportionate to the shock parameters and manifests with both path and non-path related symptoms. A DEI injury can manifest in symptomotology of a "neurological, physical and neuropsychiatric" nature. A DEI injury is best defined as a statistically grouped set of symptoms that are chronologically linked to an electric shock. Table 2 contains a list of non-path related neuropsychological symptoms that have been linked to the DEI class of electrical contacts. Table 3 contains a list of the most common physical symptoms (path and non-path) that have been linked to the DEI class of injury where the injury was not explained within the three prongs of the Traditional Model.

Table 2

Neuropsychological symptoms (Most common symptoms)

Symptom	Number of groups in common
Reduced attention span/loss of concentration	8
General physical weakness	8
Personality Changes	8
Memory loss - short term	8
Insomnia or other sleep disorders	8
Increased emotional sensitivity	8
General forgetfulness	8
Nightmares	7
Lack of motivation	7
Fear of electricity	7
Unusual anxiety	6
Sexual dysfunction	6
Feeling of Hopelessness	6
Unexplained moodiness	5
Easily confused	5

Table 3

General physical symptoms

Symptom	Number of groups in common
General physical weakness	8
Muscle Aches	8
Muscle Spasms or Twitches	8
General exhaustion	7
General fatigue	7
Stiffness in joints	7
Chronic general pain	6
Weakness in joints	6
Dizziness	5

Upon review of the literature that defines the science and study of electrical injury, it is quite clear that the definition of electrical injury has grown to include responses that two decades ago would have been dismissed as either psychosomatic or the result of a conversion disorder. Such symptomatology now has a clear and statistically sound causal connection to the underlying electrical contact. It is this evolution in the state of the science that must drive a change in the way product designers evaluate the risk of electrical injury associated with the products that they wish to bring to market.

IV. Electrical Injury Example—The Novelty Shock Pen

Let us now consider the risk of injury posed in the following electric shock scenario through the Traditional Model and Modern Model lens. (NOTE: This hypothetical scenario is based on factual situations known to these researchers.)

<u>Scenario</u>

An individual has returned to his office from a casual walk. It is a hot day and the individual's hands are mildly wet from perspiration. The unsuspecting victim is presented with an electric

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shock pen, purchased at a local novelty store. He grasps the pen in his left hand with his thumb on the top button and his remaining fingers parallel to each other. As he clicks the button, an electric shock occurs lasting approximately 0.3 s. The unsuspecting victim reports some level of pain and an inability to easily break free from the source of the current.

The question that arises is what is the extent of the risk to which this individual was exposed? Would a review of the shock received under the Traditional and Modern Models suggest that the manufacturer/designer of the pen created an undue risk of harm to the unsuspecting victim of the practical joke? Was a duty thus breached by the manufacturer/designer and if so, to what extent? Ultimately, it is a question of whether the manufacturer/designer was negligent in the design process.

Data gathering

Data were acquired for a Novelty Shock Pen by connecting the pen in parallel to a resistance used to model a human contact. Tests were run with four different resistance values as indicated in Table 4. The resistance values were varied to mimic differing levels of skin moisture. A mixed signal oscilloscope was employed to measure voltage across each resistor with respect to time. Figure 1 diagrams the experimental setup.

The shock pen was observed to output an exponentially decaying voltage pulse at an approximate rate of 167 pulses per second. Each pulse was of approximately 200 microsecond duration. Fresh batteries were installed in the pen at the start of the data gathering session.

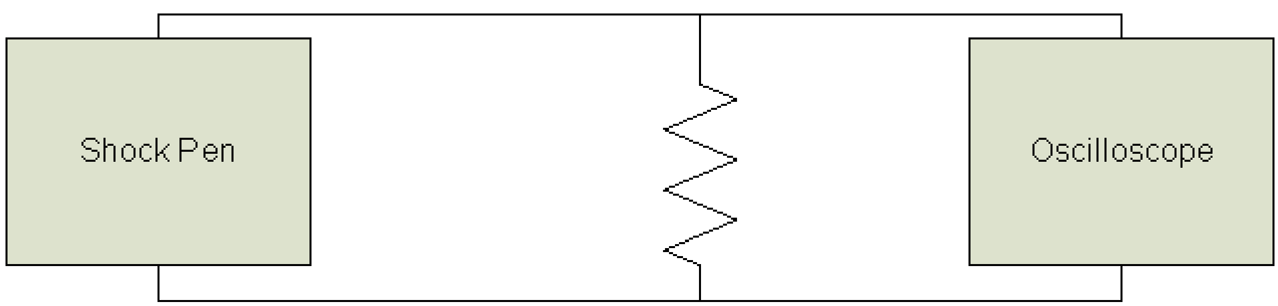

Figure 1. Experimental Setup

Energy delivered during the shock was determined in the following manner:

1. A pulse was recorded and was fit with an exponentially decaying trendline as shown in Figures 2,3,4, and 5.

2. The energy per pulse was calculated by integrating power with respect to pulse duration (time):

$$E_{Pulse} = \int_{0}^{PulseDuration} (Power)dt = \frac{1}{R}\int_{0}^{.2\mu s} (V(t))^2\, dt$$

3. The number of pulses per shock duration was calculated by multiplying the number of pulses in a second by the shock duration time:

$$N_{Pulses} = 0.3 \times 167 = 50 Pulses$$

4. The total energy imparted for the shock duration was calculated by multiplying the number of pulses per shock duration by the energy of a single pulse as calculated in step 2:

$$E_{Total} = N \times E_{Pulse}$$

The peak current was calculated by dividing the peak voltage across the resistor by the resistance. The average current for each resistance was calculated by integrating the current pulse and dividing by the pulse duration:

$$I_{Average} = \frac{1}{PulseDuration} \int_{0}^{PulseDuration} \frac{V(t)}{R} dt$$

The peak power dissipated by each resistor was calculated with the peak voltage across each resistor:

$$P_{Peak} = \frac{V_{Peak}^2}{R}$$

The average power dissipated was calculated using the average current through each resistor:

$$P_{Average} = I_{Average}^2 R$$

The results of these calculations are displayed in *Table 4.*

Table 4. Shock Parameters as a Function of Contact Resistance

Resistance	Energy Imparted	Peak Current	Average Current	Peak Power	Average Power
201.68 ¨	5.96 mJ	100 mA	18.8 mA	2.05 W	0.071 W
507.5 ¨	5.28 mJ	64 mA	13.4 mA	2.08 W	0.091 W
995.8 ¨	9.77 mJ	77.5 mA	22.3 mA	5.98 W	0.495 W
1968.1 ¨	2.10 mJ	35.9 mA	6.14 mA	2.31 W	0.074 W

V. Discussion

The data indicated that the peak current ranged from 100 mA. (201 ohm resistance) down to 35.9 mA. (1968 ohms). Similarly average current ranged from 18.8 mA to 6.14 mA, noting that the average current was calculated based only on the “on-time” for the pulse and did not include “off-time” between pulses. Including “off-time,” average current would be dramatically smaller. Total energy imparted during the shock ranged from 5.96 milli-joules down to 2.1 milli-joules.

Continued on Page 26

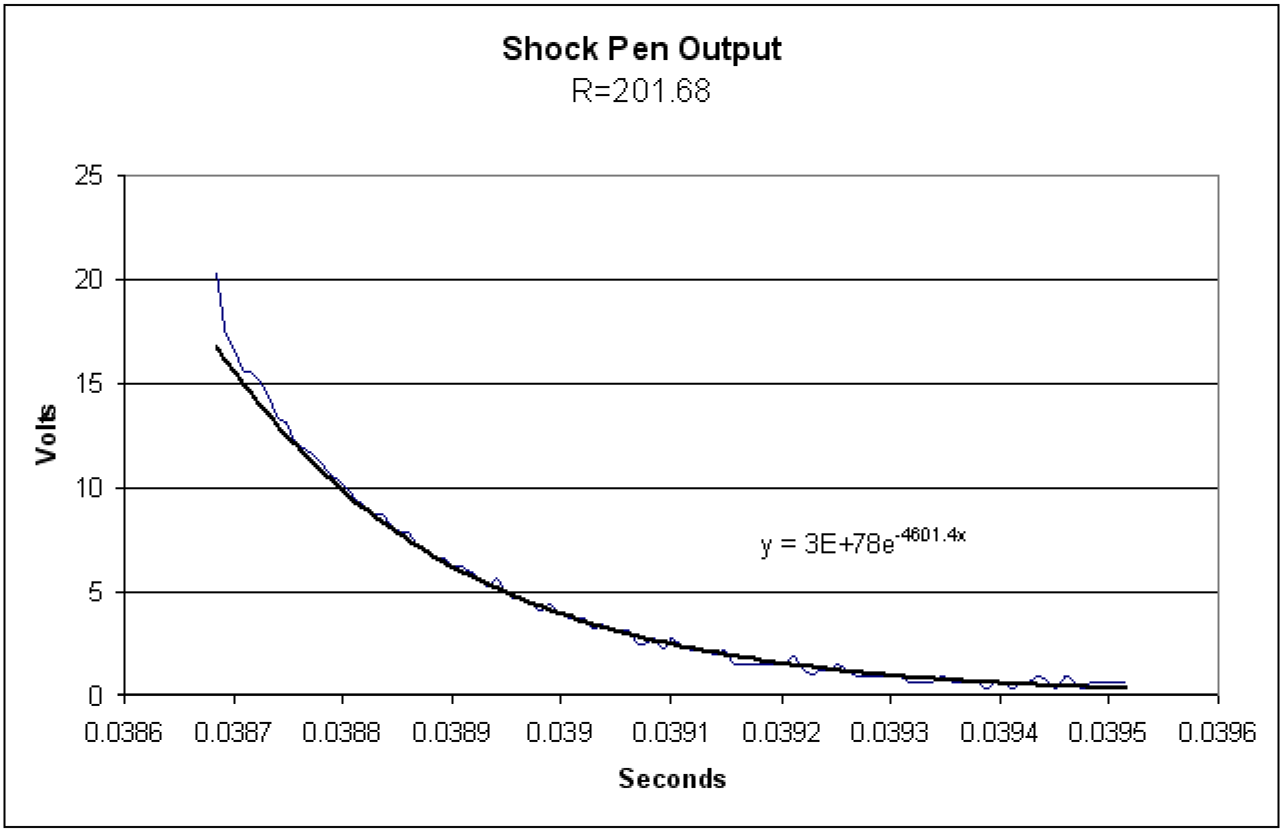

Figure 2. Pen Output For R = 201.68 Ohms.

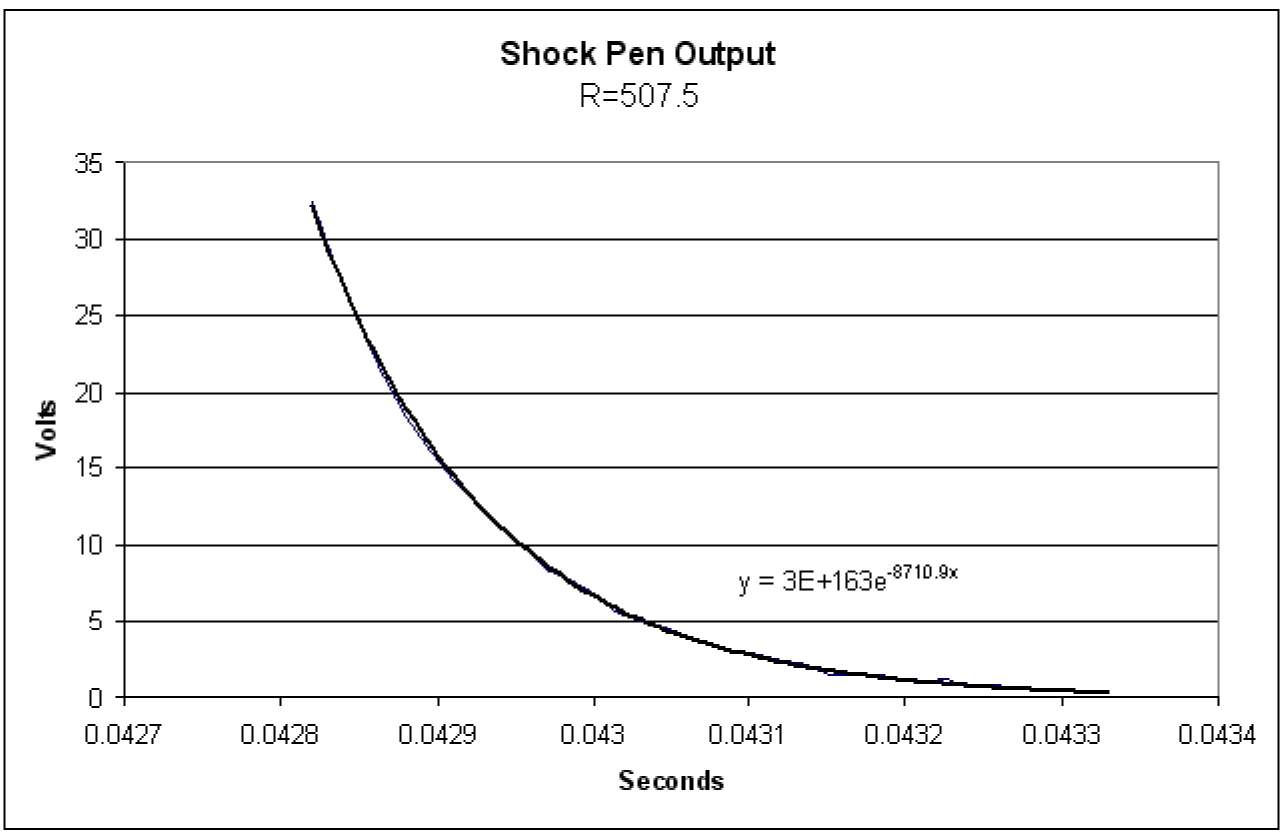

Figure 3. Pen Output For R = 507.5 Ohms.

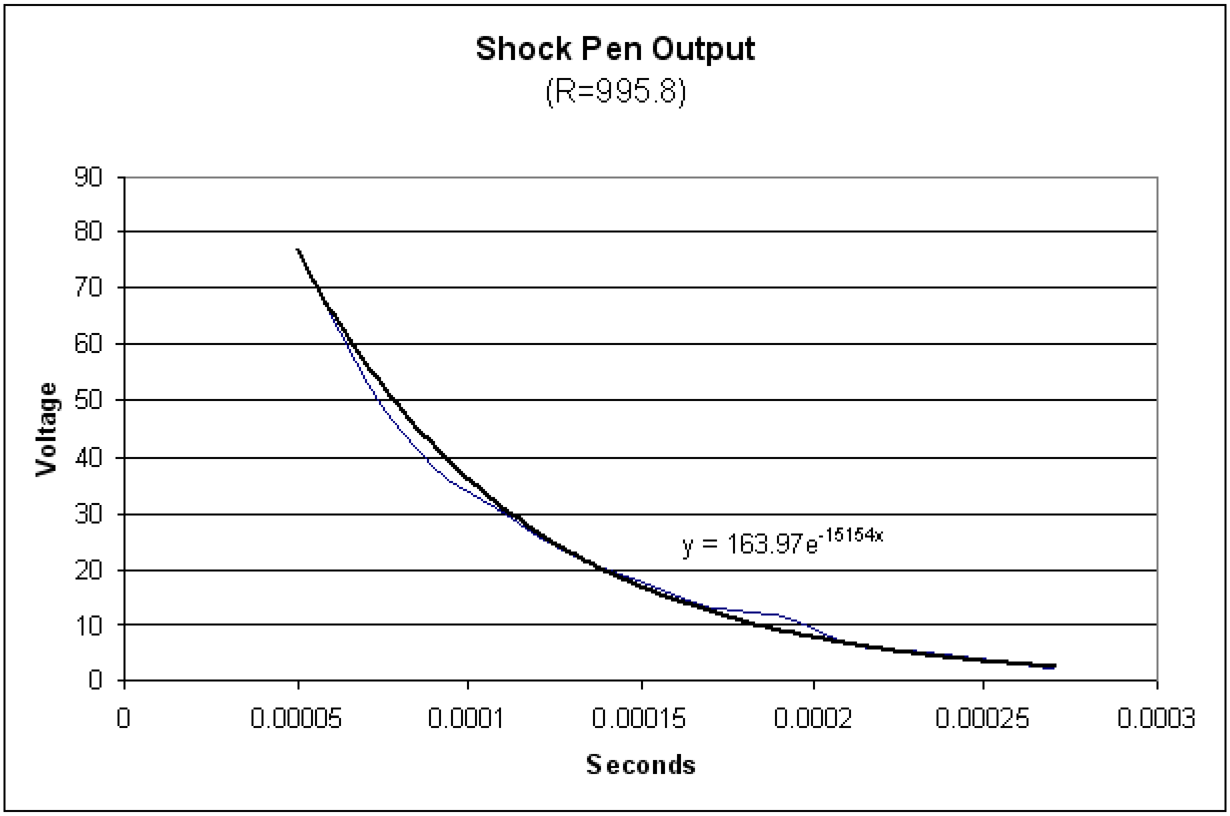

Figure 4. Pen Output For R = 995.8 Ohms.

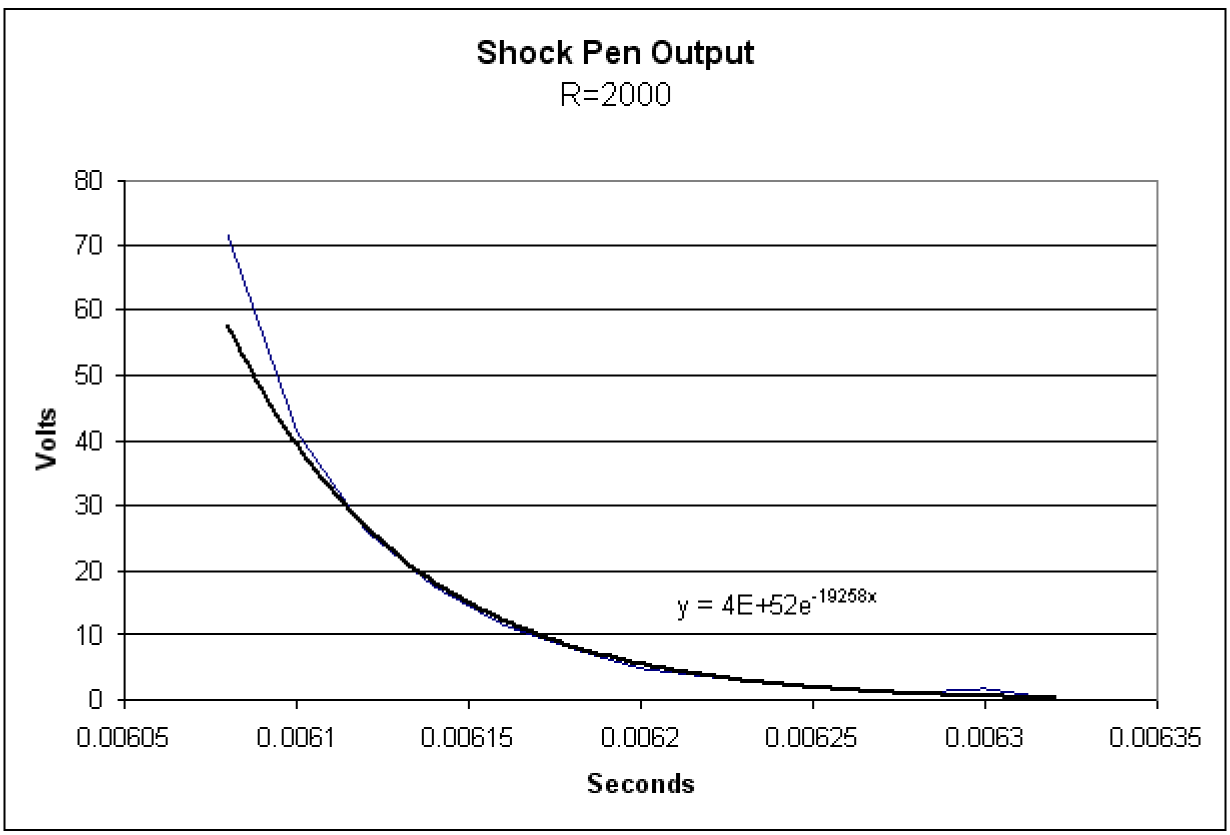

Figure 5. Pen Output For R = 1968 Ohms.

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In reviewing the scenario and examining how the pen was wired, the entry point for the current is the left thumb and the exit point is the left palm. Although resistance between different points on the hand is not reported in the literature, one can extrapolate from that which is reported and assume that with the presence of perspiration to break down skin resistance, the resistance between the entry and exit points in the hand can be as low as a few hundred ohms. Dry skin will of course have much higher resistance. (These assumptions led to the choice of resistors for the model.)

Anticipated Traditional Model Response

Noting that the current pathway did not include the heart or the respiratory muscles, per the traditional model, there existed no foreseeable risk of ventricular fibrillation or respiratory arrest. The only remaining prong in the traditional model analysis of risk is the risk of thermal injury. While the peak current was observed to be 100 mA (which should not be considered trivial), the brevity of the shock thus meant that a relatively small amount of energy was delivered during the shock. Further, the energy dissipation would be limited to the area between the entry and exit points on the hand. As such, no major organ systems were placed at risk for thermal injury. Because the energy is so small, the risk of thermal injury is also very small. *NOTE: As a point of reference, a 0.1 second, limb-to-limb shock from a household outlet would deliver approximately 1.44 joules of energy. The largest shock received from the shock pen was a mere 4/1000 of that energy.*

Under the "Traditional Model" this shock can be anticipated to cause some pain, a foreseeable startle response, and some level of muscle contraction (see Table 1) but it is unlikely to cause any foreseeable long or short term injury.

Anticipated Modern Model Response

Understanding the risk posed under the modern model is far more difficult. It is not as cleanly cut and dry as the traditional model. No one knows for sure where the lower threshold for risk of injury really exists under the modern view of electrical injury. Disproportional and non-path responses are the rule, not the exception, for the Modern Model. Still, the energy is low by comparison to other DEI cases that these researchers have studied and the theoretical current pathway is extraneous to the bulk of the body volume and at least in theory, the current does not touch major organ systems, or major neural pathways.

Ultimately, one would have to conclude that because of the unknowns in the modern model, there is a foreseeable risk. However, based on the body of DEI type cases studied, the risk is presumably small and is not clearly or easily quantifiable given the state of our modern understanding of electrical injury.

Risk of Secondary Injury

When examining the risk from a shock pen, one should not end the analysis by considering just risk of primary injury (modern or traditional) caused by the flow current. One must also consider the risk of secondary injury that is common to almost all electrical contacts with current levels exceeding the realm of sensation (around 1mA), pain (around 9 or 10 mA.) or let-go (8-14 mA.). This shock pen clearly falls into the category where secondary injury is a foreseeable risk. By design, shock pens are intended to startle. It is well reported and well understood that secondary injury resultant from the startle response associated with electric shocks can be quite significant. Such injuries include falls and impacts as individuals attempt to take flight from the source of the current. As such, perhaps the most foreseeable risk and greatest probability for injury will be of a secondary nature.

V. Legal Discussion:

Ultimately product designers are confronted with an analysis that they must follow so as to avoid negligence in the design process. For any product, the designers must assess the foreseeability of product failure and associated risk of injury. When the risk is such that injury is foreseeable, the product designers have a duty to resolve the risk in one of three ways. 1) Where ever possible, the design should be modified to remove the risk; 2) When removing the risk is not possible, the design should be modified to cause failure in a manner that will cause no harm; and when that is not possible, 3) the manufacturer should resort to clear and proper warnings.

When considering the shock pen, although the risk of Traditional Model injury is not foreseeable, there is a small foreseeable risk of Modern Model injury and a very clearly foreseeable risk of secondary injury. Given the basic design analysis, (coupled with the lack of real value associated with shock pens), there is some question as to whether shock pens can be designed so as not to create the risk of negligence on the part of the designer. Accepting that the risk is foreseeable, to design the pen so as not to shock would defeat the whole purpose of the pen. Even a small shock (intended to startle), creates the foreseeable risk of secondary injury. Similarly, there appears no way to modify the design so as to fail on the side of safety since the electric shock is the intended goal of the pen. Finally, since surprise is inherent to the use of the pen, intended recipients of the pen are denied any fair warning from the manufacturer/designer. The result is that manufacturer warnings will consistently fail to reach their target.

As an additional note, the designer should recognize that use of the shock pen can be viewed in some circumstances as *a willful attempt to inflict injury upon the person of another* or as *an unlawful touching of another without justification or excuse* which defines assault and battery.

VI. Conclusions

To abate negligence in the design process, the designer must incorporate in an analysis of risk a study of both the Traditional and the Modern models of electrical injury. Both are recognized and accepted in the literature and as such, injury under either model should be foreseeable in a proper design review. As noted in the discussion above, a device as simple as a novelty shock pen provides an excellent example of the extent of the risk analysis to be performed and the risk faced by designers when the proper analysis is ignored.

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- Technical direction or management of important scientific or engineering work with evidence of accomplishment
- Recognized contributions to the welfare of the scientific or engineering profession
- Development or furtherance of important scientific or engineering courses in a program on the "reference list of educational programs" (REP list)
- Contributions equivalent to those of the above in areas such as technical editing, patent prosecution, or patent law, provided these contributions serve to advance progress substantially in IEEE-designated fields.

In addition, candidates for Senior Member grade must supply three references from current IEEE members holding the grade of Fellow, Senior Member, or Honorary Member.

There is no cost to convert to a Senior Member Best of all and there is also increase in your IEEE membership dues.. While many other professional societies charge higher dues for higher membership grades, the IEEE does not. There is no increase in cost - only an increase in the IEEE's recognition of your technical and professional accomplishments. You'll also receive a Senior Member plaque and one new IEEE Society membership, both free of charge.

OK, so How do You Apply for the Senior Membership Grade

Once you determine that you fulfill the requirements for Senior Member grade, identify your three references who must be IEEE Senior Members or Fellows. If you have difficulty in locating individuals to serve as your references, contact your local Section or Chapter or us, at the PSES Society Membership Development Committee (see below). For help in contacting your Section/Chapter Chair, send an e-mail to senior-member@ieee.org.

If you have been notified by a Section or Chapter officer that they intend to nominate you for Senior Member grade, the nominator serves as one reference as long as he/she is a Senior Member or Fellow. Otherwise, the required number of references is still three in addition to the nomination. Alternatively, contact your Section or Chapter Chair and ask if they can nominate you.

You do not need to pass any exam to be elevated. You have already been "tested" throughout your entire career. The Senior Member application is simply a brief one-page documentation of your career that is used to evaluate your qualifications for this membership grade.

The application process is fairly straightforward. The Senior Member application form is available in 3 formats:

- Online version
- Downloadable version
- Electronic version

This form can be completed by the applicant and submitted electronically as an email attachment. If you are a Nominator, you can fill in your portion of the form and forward it to your nominee. The nominee can then complete the rest of the form and send it as an email attachment as instructed.

To expedite the processing of your application, we suggest submitting your application online or sending the electronic version to senior-member@ieee.org. **Make sure that you have contacted three people to serve as your references** and that they submit the reference forms in a timely manner.

Continued on Page 36

2008 IEEE Symposium on Product Compliance Engineering

Product Safety Engineering Society

Sponsored by the IEEE Product Safety Engineering Society
20-22 October 2008 Austin, Texas
Austin Marriott North

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Gary Schrempp
Gary_Schrempp@Dell.com

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At-Large Members
Jim Bacher
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Daniece Carpenter
Elya Joffe
Henry Benitez
Ken Thomas

Call for Papers, Workshops, and Tutorials

The IEEE Product Safety Engineering Society seeks original, unpublished papers and tutorials on all aspects of product safety and compliance engineering including, but are not limited to:

- **Product Safety:** Consumer, medical, computer (IT), test and measurement, power supplies, telecommunication, industrial control, electric tools, home appliances, cellular and wireless, etc.
- **Product Safety 101:** Papers / presentations intended for new safety engineers. This will include certification processes, product evaluation and testing, report writing, and working with designers to get it right the first time.
- **Safety Subjects:** Electrical, mechanical, fire, thermal, chemical, optical, software, functional, reliability, etc.
- **EMC / RF:** Electromagnetic emissions, electromagnetic immunity, regulatory, Introduction to EMC/RF for the safety engineer and compliance engineer.
- **Components:** Grounding, insulation, opto-couplers, capacitors, transformers, current-limiters, fuses, power line filters, ferrite, environmental, electromagnetic emissions, electromagnetic immunity, regulatory, etc.
- **Certification:** Product safety, electromagnetic emissions, electromagnetic immunity, environmental, processes, safety testing, regulatory, etc.
- **Standards Activities:** Development, interpretations, status, interpretations, country requirements, Laboratory Accreditation, etc.
- **Safety Research:** Body physiological responses to various hazardous energy sources, unique safeguard schemes, etc.
- **Environmental:** RoHS, WEEE, EuP (Energy-using Products), Energy Star, Packaging Directives, REACH (Chemical), CeC, etc.

Mark your calendars to attend the 2008 IEEE Symposium on Product Compliance Engineering.

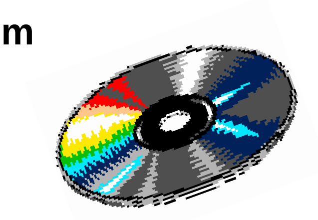
Author's Schedule

Intent to present and topic (e-mail) April 29, 2008
Draft e-paper June 1, 2008
Notification of Acceptance July 6, 2008
Complete e-paper August 17, 2008

See http://www.ieee-pses.org/symposium/index.html#CFP for more details on requirements and dates.

www.ieee-pses.org/symposium

2004 / 2005 / 2006 / 2007 IEEE-PSE Symposium



CD Purchasing Information

SYMPOSIUM PAPERS ON CD:

The Product Safety Engineering Society continues to offer the 2004 IEEE PSES records for sale. The cost for the CD is $35 plus shipping and handling for IEEE members; $50 plus shipping and handling for non-IEEE members. At this time, check or money orders are the means for payment. Please provide the following information:

CDs to be shipped to- (Please print or type.)

Name:____

Mailing address::____

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IEEE member number:__________________

Shipping and handling: $5 per CD

Payment: Check or money order.

Make Check or money order to: "IEEE Product Safety Society"

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Quantity 2004:____ x $50 = _________ for non-IEEE members
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S&H: QTY_____ x $5 = _________

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Send payment to:

IEEE Product Safety Engineering Society
c/o Richard Georgerian, PSES Board of Directors
7103 Sioux Court
Longmont, CO 80504
U.S.A.

Depending on stock availability allow 2 to 3 weeks for delivery.

For details on the Nominate-a-Senior-Member Initiative, guidelines, the online application and reference forms, simply visit http://www.ieee.org/organizations/rab/md/sminitiative.html. For application forms, visit:http://www.ieee.org/organizations/rab/md/membershipforms.html

What will you receive?

In addition to the prestige and recognition, which are the true and most significant benefit you receive, the IEEE also provides you with some more "material" benefits, including:

- An attractive fine wood and bronze engraved Senior Member plaque to proudly display
- A gift certificate of up to $25.00 toward one new Society membership
- A letter of commendation to your employer on the achievement of Senior Member grade (upon the request of the newly elected Senior Member)
- Announcement of elevation in Section/Society and/or local newsletters, newspapers and notices

How can your Local Chapter or Section Help?

Chapters are the core of membership development as well as technical activities. That is why chapters, first and foremost, should strive to nominate and support the nomination of members to the Senior Member grade. To achieve that goal, chapters may try one or more of the following initiatives:

- Encourage qualified members to apply for Senior Member elevation.
- Form local Senior Member nomination committees
- Use SAMIEEE data base to identify potential SM candidates and assist applicants identify SM references
- Assist candidates in finding Senior Members and Fellows who can serve as references.
- Explain the qualifications and have applicants' complete applications at a special Senior Member Nomination/Elevation session
- Have Fellows and Senior Members on hand to meet applicants and for applicants to acquire the needed references
- Encourage newly elected Senior Members take an active role serving as references
- Conduct Senior member elevation events at least twice a year. (see the box below: *"Chapter Chairs: Plan a Senior Member Nomination Night*")

This will also help your Section earn a rebate at the end of the year through the Nominate a Senior Member Initiative.

We, in the PSES, are here to help you become a Senior Member

For answers to questions about the application process or about the grade of Senior Membership in general, contact Ken Thomas, PSES VP for Member Services, at kthomas@GLOBALSAFETYSOLUTIONS.NET or the above signed at eb.joffe@ieee.org. We will be more than glad to help and lead you through the process, and even act as one of your nominators, if you are eligible to the grade.

Summary

We all work hard throughout our careers, but don't always realize the extent of knowledge we gained or how much responsibility we have accepted over the years. Think back to when you began your career. With time and experience, your knowledge has grown, your responsibilities have increased, and you are now one of the engineers the company counts on. So take the time to get recognized for it.

The grade of Senior Member is the highest a member may attain through application, and reflects professional recognition of your peers for your technical and professional excellence. The Senior Member Grade by its own merit is an indication of your accomplishments in your professional career and will promote you to your company and profession

Surely you may consider this gratifying to know that you have made a contribution to our profession and Society even though you may not have designed the next generation of engineering technology... It is worthwhile becoming a Senior Member if not for professional reasons, then at least for personal satisfaction.

Useful Web Resources

http://www.ieee.org/web/membership/Admission-Advancement/Senior_Member_Requirements.html

http://www.ieee.org/organizations/rab/md/sminitiative.html

http://www.ieee.org/organizations/rab/md/membershipforms.html

http://www.ieee.org/portal/pages/membership/understanding.html#Senior_Member

Chapter Chairs: Plan a Senior Member Nomination Night

Are you looking for a way to make a Senior Member elevation easier to arrange for colleagues in your area? Plan a Senior Member Nomination Night at your local Chapter. With Senior Members and Fellows willing to coach candidate members, the evening becomes a social networking event.

First, identify Senior Members and Fellows through your Section's membership database. They can't all have to be PSE Society members: Simply IEEE members, holding Senior Member Grade or higher. Contact them personally to ensure their commitment to coach candidates and make this a successful event. Several higher grade Members per candidate Member is preferred. Experience shows that a recommended ratio is two Senior Members for each Candidate.

When you invite prospective members who are appropriate candidates for Senior Grade elevation, remind them to review the requirements [hyperlink to http://www.ieee.org/organizations/rab/md/smrequirements.html] so they are prepared. They should bring their resume to help guide conversations with the higher grade members offering to provide references.

In the evening of the event, the Senior Members and Fellows work "one on one" with candidate members, clarifying the significant performance requirements of the application process. Once documented, this makes the reference writer's job much easier. When the Society or Section takes the job opf nominating the candidate, only two references instead of three are required.

The Senior Member process is all online [hyperlink to http://www.ieee.org/organizations/rab/md/smprogram.html] now. Schedule the evening in a room with network access and a number of computers. Have some snacks and beverages to keep the evening casual and the conversation flowing. Chatting around the tables and making careers the feature of the evening, offers the chance to exchange backgrounds and talk about useful career directions.

New PSES Members from 29 July 2007 Through 31 March 2008

Adam Black
Alan George Knight
Alexander Nizov
Alvin D Ilarina
Anders Sandberg
Andre R Fortin
Andreas Wengenroth
Andres Kipen
Andrew Doering
Andris Rusko
Arnold Offner
Asa H Hill
Brian M Slowik
Brian R Smith
Carl E Conti
Chandler G Sinnett
Chee K Fong
Chor Shoon Wong
Christopher Robert MacDonald
Craig Kaneshiro
Daniel Bejnarowicz
Daniel T Fitzgerald
David Ciaffa No USA
Denis Pomerleau
Dharmesh S Panchal
Douglas Powell
Durga Prakash K
Edward A Gold
Edward Y Karl
Evan D Gould
Ferdinand Dafelmair
Francesc Daura-Luna
Frank Sarcevic
Fred Buton
Galina G Yushina
Gemma J Bennett
Gilbert Dominguez
Giovanni Inganni
Glenn L Mercurio
Glyn R Garside
Govinda Rao V Rao
Gregory Dale
Ian McDonald
Ismael B Agasino
Issa Ngwele
J L Kalina No
James W Christgau
Jay R Goetz
Jeffrey J Bush
Jennifer L Laine
Jindi Shao
Jiri Prinosil
Joe Borreggine
John Trottier
John B. Salmon
John H Mowbray
Jon Kalfus
Jonathan G Jordan
Joseph E Swanzy
Joseph M Jungbluth
Kam-San Wong
Keith D Ness
Khawaja Abdul Waheed
King Chui Chan
Lingfeng Chen
Lucky Yulius Joeng
M Sedaghat
Malcom Frederick
Marshall David Cox
Martin Fedor
Martin Robinson
Martin L Stein
Martina Breisch
Mathew B Aschenberg
Matthew Raia
Mick J Walton
Mihai V Nemes
Mitsunori Hase
Nandhinidevi S S
Nicholas F Garinger
Nikhil Krishen
Olutola Samson Gbuyiro
Patrick Patterson
Patrick G Salas
Patrick J Blomquist
Paul Herrick

Peter Olsen
Peter F Kelleher
Peter M Hart
Philip Tuckner
R L Martin
Raghavendra Choudary Chitturi
Rajendra Kulkarni
Randall A Marquardt
Raymond C Denchfield
Richard J Wagner
Richard L Johnson
Richard L Stern
Robert W Miller
Roberto C Pasos
Ron Birrell
Ron Garcia
Roselli F Tria
Ryan Parks
S Mohamad Dawood Farzan
Samuel Baum
Selman Demirel
Stephane B Georget
Stephen C Whalen
Stephen J Prachyl
Steven Craig Halme
Thomas F Keber
Thomas R Walden
Tim Durant
Todd P Salisbury
Varun Toshniwal
Walter E. Lorber
William E Anderson
Yakov P Shkolnikov
Yog R Kubba
Yue Man Au

Our new members are located in the following countries: Argentina, Australia, Canada, China, Czech Republic, Denmark, Germany, France, India, Iran, Ireland, Hong Kong, Latvia, Netherlands, Nigeria, Pakistan, Sweden, Spain, Switzerland, Turkey, United Kingdom, USA

The Product Safety Engineering Newsletter is published quarterly during the last month of each calendar quarter. The following deadlines are necessary in order to meet that schedule.

Closing dates for submitted articles:

1Q issue: February 1
2Q issue: May 1
3Q issue: August 1
4Q issue: November 1

Closing dates for news items:

1Q issue: February 15
2Q issue: May 15
3Q issue: August 15
4Q issue: November 15

Closing dates for advertising:

1Q issue: February 15
2Q issue: May 15
3Q issue: August 15
4Q issue: November 15

Booked your trip to the 2008 Symposium on Compliance Engineering yet?

Institutional Listings

The
Product
Safety
Engineering
Newsletter

Gary Weidner
GW Technical Services Inc.
2175 Clarke Drive
Dubuque, IA 52001-4125

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