EMC
TEST REPORT

SUSCEPTIBILITY TEST

How reverb chambers work

Dan Romanchik, Technical Editor

Reverberation chambers have become increasingly popular among engineers who need to test the susceptibility of electronics equipment to radiated RF. As evidence, consider last year's IEEE symposium on Electromagnetic Compatibility (August 19–23, 2002, Minneapolis, MN), at which seven papers and one workshop covered how to use this technology.

How do reverberation chambers work? Basically, a reverberation chamber is a shielded enclosure with a stirrer/tuner. An antenna radiates RF energy into one corner of the chamber, and most of the waves reflect off the wall (**Figure 1**). Without the stirrer/tuner, the energy would quickly set up standing waves in the chamber. As a result, the field strength would not be uniform, and testing using this field would not be effective.

The stirrer/tuner has motors that rotates its arms. The revolving arms change the path lengths for the injected RF energy as well as the number of waves that impinge on a specific point. The result is that the field strength magnitude at any point in the chamber differs from the field strength magnitude at other points, and it changes as the stirrer/tuner rotates.

In addition, an effective stirrer/tuner perturbs the field such that it yields a statistically isotropic, randomly polarized, uniform field across a large portion of the chamber volume. The field strength continuously varies, but the average strength over time remains constant. The maximum field strength will be 7 to 8 dB higher than the average field strength in a properly operating chamber.

There are several good reasons for using reverberation chambers instead of other test methods:

- They provide high field strengths for moderate input power, achieving field strengths higher than 25 V/m for inputs of around 1 W.
- Reverberation chambers provide large test volumes—up to 50% of the chamber volume.
- Testing in a reverberation chamber is a better simulation of a complex field in a closed environment, as the field acts like a random array of plane waves coming from all directions. You needn't run multiple tests beaming the source at the unit under test at different angles.
- You can use reverberation chambers for both immunity testing and emissions testing.

Using a reverberation chamber does have drawbacks though. For example, because the field is random, the test does not provide any information about the direction or polarization of radiation that may cause a test to fail. Also, when doing radiated emissions tests, you can only measure the total radiated power of a UUT, not the electric field at a specified distance, as required by many test standards. Nevertheless, I expect the advantages to outweigh these disadvantages, and the use of reverb chambers to increase in the future. □

Fig. 1 Companies can use reverberation chambers to test large UUTs because they provide relatively large test volumes. Note the stirrer/tuner in the rear of the chamber.

Photo courtesy ETS-Lindgren and Chrysler.

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Reference

1. *Proceedings of the IEEE International Symposium on Electromagnetic Compatibility,* Minneapolis, MN, August 19–23, 2002. IEEE, Piscataway, NJ. http://www.ieee.org.

For more information

Goldsmith, Kevin, "Reverberation Chambers—What Are They?" *IEEE EMC Society Newsletter Online,* Fall 1999. http://www.ieee.org/organizations/pubs/newsletters/emcs/fall99/contents.htm.

Dan Romanchik has a BSEE and 12 years of test engineering and engineering management experience. He has been covering the test and measurement and automotive industries for the past 14 years.

EDITOR'S NOTE

My call is KB6NU, and I have an EMC problem

Dan Romanchik, Technical Editor

Although I have held an amateur radio license for many years, I was never very active. All that changed last summer after I took part in my radio club's Field Day activities. I had so much fun working 15-m CW that I decided to get back on the shortwave bands.

The first antenna I put up was a simple 20-m dipole, and I had pretty good success with it, regularly contacting stations in Europe and South America. I got a little bored with 20-m CW, though, and decided to put up a 40-m dipole. That's when the fun started.

After stringing out the antenna and tuning it up, I went down to my shack to put the pedal to the metal, so to speak. Almost as soon as I keyed down, though, I heard my wife open the door to the basement, and yell, "What are you doing down there?" Not only was my signal coming in loud and clear over the computer speakers, it also was activating the garage door opener.

I didn't have time to mess with it that day, so I just took down the antenna, and I've since put up a different 20-m antenna–this time a ground plane made out of wire. It works about as well as the 20-m dipole—if I can hear other amateur radio stations, I can work them—and the garage door stays shut.

I still want to get back on 40-m one of these days, though. Any ideas you have would be appreciated. □

Contact Dan Romanchik through e-mail at dan@danromanchik.com.

NEWS

IEC holds EMC workshop in Beijing

DURING THE INTERNATIONAL Electrotechnical Commission (IEC) General Meeting in Beijing, held in November 2002, the Advisory Committee on Electromagnetic Compatibility (ACEC) held two workshops to familiarize technical committee experts with its work in the field of electromagnetic compatibility (EMC), and to help the technical committees become more efficient in preparing IEC product standards that involve EMC considerations.

The workshops included presentations by Dr. William Radasky (chairman of the ACEC), Peter Kerry (chairman of the International Special Committee on Radio Interference—CISPR), Diethard Moehr (secretary of Technical Committee 77, which covers electromagnetic compatibility), IEC Technical Director Jean-Pierre Brotons-Dias, and IEC Technical Officer Rémy Baillif. Attendees were given a CD-ROM containing the presentations from the workshop and a flyer entitled "EMC for Product Committees: A short guide to IEC Guide 107." The CD-ROM is available free of charge from the IEC's Central Office. To obtain a copy, contact Dennis Brougham at db@iec.ch. □

White paper addresses ESD

THE ESD ASSOCIATION HAS published a white paper covering electrostatic discharge (ESD) phenomena, an overview of ESD effects on electronic chips and systems, and a summary of the challenges involving ESD as further advances are made in semiconductor technologies. The 53-page "ESD Phenomena and the Reliability for Microelectronics" includes topics such as controlling ESD from the factory point of view, designing ESD protection into chips, methods for measuring and testing ESD levels, the impact of advanced IC technologies, simulation of ESD effects, and the challenges of the next decade. Copies of the paper can be purchased from the ESD Association for $35. http://www.esda.org. □

IEC releases report on voltage dips

THE IEC RECENTLY RELEASED IEC/TR 61000-2-8 (2002-11) Ed. 1.0, "Electromagnetic compatibility (EMC)— Part 2-8: Environment–Voltage dips and short interruptions on public electric power supply systems with statistical measurement results." This technical report describes the electromagnetic disturbance phenomena of voltage dips and short interruptions in terms of their sources, effects, remedial measures, methods of measurement, and measurement results (insofar as these are available).

The dips and interruptions are discussed primarily as phenomena observed on the networks of public electricity supply systems and having an effect on electrical equipment receiving its energy supply from those systems. The 89-page report costs CHF 138 (approximately $100 US). http://www.iec.ch. □

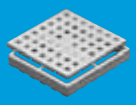
Meetings

ESD Seminar
MARCH 26-27, ROME, NY
ESD Association, 315-339-6937
http://www.esda.org

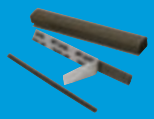
EMV 2003 Augsburg
APRIL 1-3, AUGSBURG, GERMANY
Mesago Messe Frankfurt
+49-711-619-46-806
http://www.e-emc.com

Reverberation Chamber, Anechoic Chamber, and OATS Meeting
APRIL 28-30, AUSTIN, TX
IEEE, http://www.ieee.org

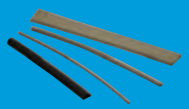
Spring 2003 IEEE International Symposium on EMC
MAY 11-16, ISTANBUL, TURKEY
IEEE, http://www.ortra.com/emc2003


Board-level Shields


Fingerstock

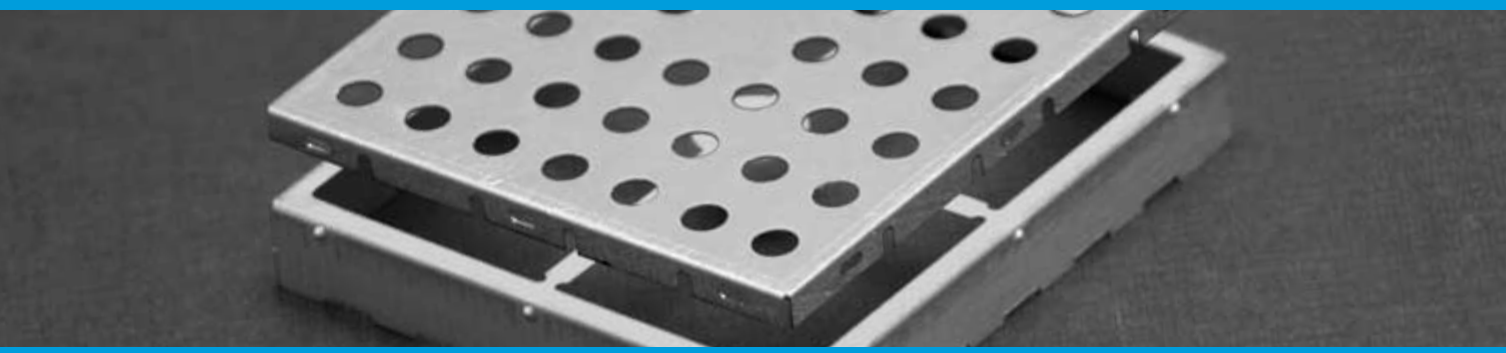

Fabric-over-Foam


Form-in-Place


Conductive Elastomers


Microwave Absorbers


Wire Mesh



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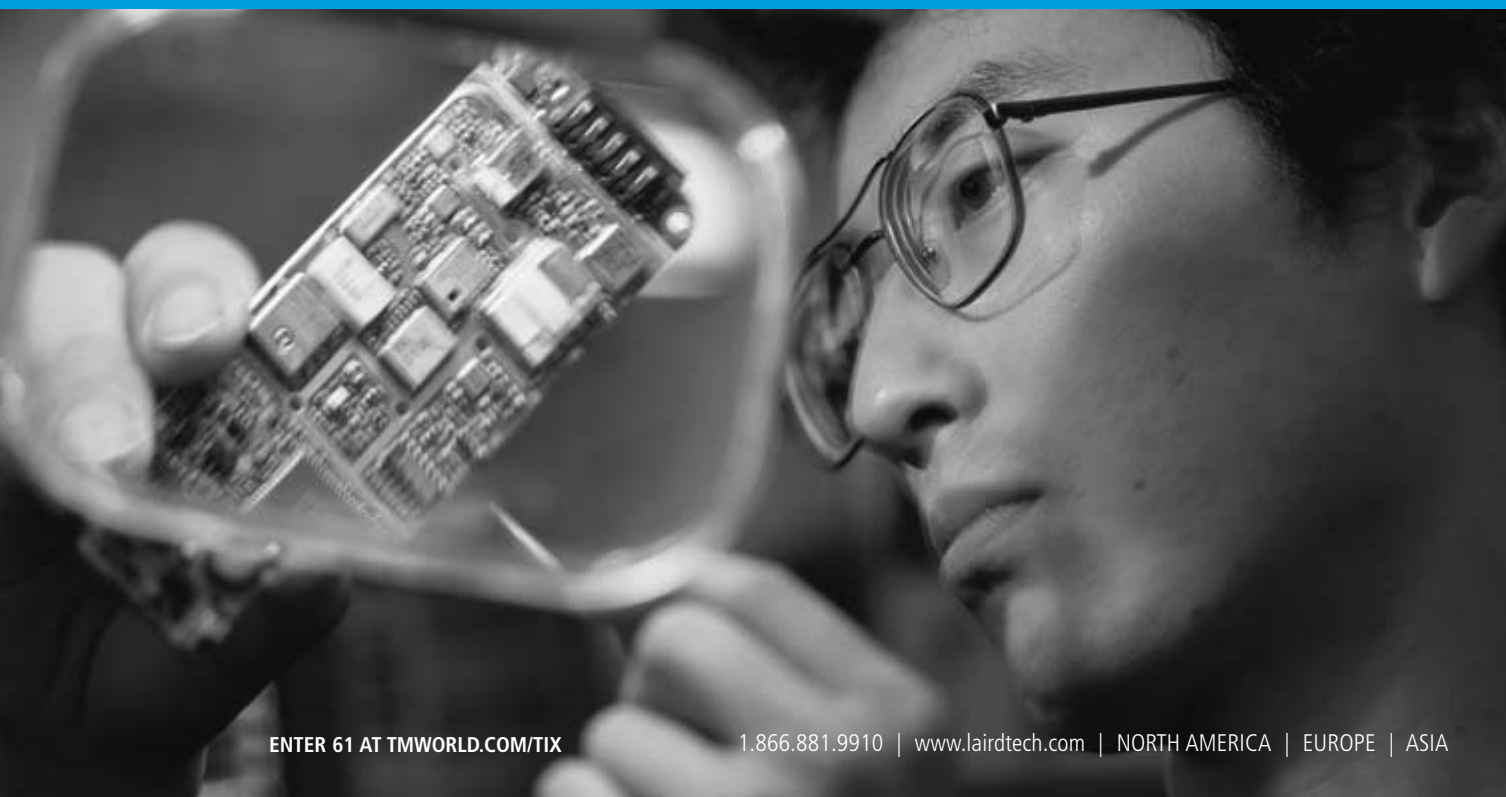

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CERTIFICATION

NARTE sets the standard for EMC engineers

Dan Romanchik, Technical Editor

In 1987, the Naval Air Systems Command (NAVAIR) determined it needed a program to ensure the qualifications of EMC engineers and technicians working on NAVAIR projects. The following year, NAVAIR selected the National Association of Radio and Telecommunications Engineers (NARTE) to design and implement that program. Today, the Navy, as well as other government agencies and high-tech companies, uses NARTE certification as a benchmark when comparing the capabilities of companies and test labs.

NARTE certification consists of four major components:

- *Experience.* To gain accreditation, an engineer must have nine years of work experience. During this time, the engineer must actually be doing EMC engineering work. The rules explicitly identify work that does not qualify for credit, including management positions (in which more than 20% of one's time is spent on administrative matters or does not involve direct supervision of EMC engineers); marketing; mechanical, civil, or architectural engineering; computer programming (where the programming is not related to the development of EMC analysis or design programs); and military experience that does not involve supervision of EMC engineers.
- *Education.* Graduation from an accredited college engineering program gains an applicant credit for four years of work experience. Graduate study gains an applicant credit for a maximum of one additional year, and teaching experience qualifies for up to two years of experience.
- *References.* Applicants must submit the names of three references, all of whom will be asked about the character and technical competence of the applicant. One of the references must be a supervisor.
- *Examination.* Assuming that all the other qualifications have been met, the applicant is given a test that covers 26 EMC subjects, including bonding and grounding, shielding, EMC test plans, ESD, lightning protection, EMI prediction and analysis, antennas, and filter theory.

Taking the Test

The test consists of two sections, each having 48 questions. Each section has eight questions dealing with military EMC standards that test takers can skip if they don't apply to their work. The entire test must be completed in eight hours. It is an open-book test, and test takers can use any reference materials they think will be helpful. A passing grade is 70%.

If you decide to take the test, there are steps you can take to increase your chances of passing. NARTE publishes a PowerPoint presentation that gives tips on how to pass the test the first time:

- *Stick with your first answer.* Your first response is probably the correct response.
- *Limit reference material.* Bring copies of standards and one or two general handbooks common to the field. If you must bring textbooks, limit yourself to one or two and use sticky tabs to flag those sections to which you want to refer.
- *Keep track of the time.* Jot down time checks on a sheet of scratch paper or on the examination booklet so you don't fall behind. To complete the 96-question test in eight hours, you will have to answer 12 questions per hour, or one every five minutes. By pacing yourself as you take the examination, you won't fall so far behind that you'll have to leave questions unanswered at the end.
- *Answer every question.* NARTE does not take points off for wrong answers, so even if you have to guess, it's to your advantage to do so. If you would like to dispute a question, mark your comments and explanations in the exam booklet. Your contention will be reviewed by NARTE.

Don Sweeney, a NARTE-certified EMC engineer and long-time consultant, also has advice for those taking the test. First, read each question thoroughly and determine what it is really asking. Next, read all the answers. Don't stop at the first one that looks correct, but instead choose the best one after reading all the options.

To help engineers prepare for the test, Sweeney's Web site, http://www.dlsemc.com, includes the "NARTE Question of the Week." These questions are similar to the ones asked on the test, and the Web site gives not only the answer to the multiple-choice question but also a full explanation of the answer. Answering these questions will also help you decide which resource materials to bring with you to the real test.

Is it worthwhile?

I asked several engineers whether NARTE certification was worth pursuing. I found that not only was it worth obtaining, but in many cases, it is a requirement. Scott Lytle, EMC laboratory manager for Yazaki North America (Canton, MI), said, "It is not required to be hired, but I do require them to actively work on getting certified once they are hired."

Kimball Williams, senior staff engineer at Underwriters Laboratories, (Canton, MI), notes that certification is "not a hard and fast requirement for employment," but that it's a qualification that's definitely a plus. Once engineers are hired, Williams says, "They are 'encouraged' to seek NARTE certification."

Certification is prized because many customers now require that test labs be accredited, and one requirement for accreditation is having

experienced engineers on staff. NARTE certification is one way a lab can meet this requirement. Notes Lytle, "Our customers are the vehicle OEMs who require that EMC testing laboratories be A2LA-accredited. NARTE certification is one of the requirements for being an A2LA Laboratory Supervisor, unless you have an MSEE plus three years lab experience or BSEE with five years lab experience."

I then asked the two men if, in general, NARTE-certified engineers are more qualified than those who do not have certification. Both men agreed that they are. Lytle said those who care enough to get the certification are the same engineers who care enough to take care of all the details and do the job right. Williams says, "Making the effort to study for—and then pass—the NARTE exam shows a high level of dedication and commitment."

In 1995, NARTE began offering an ESD certification in addition to the EMC certification. For more information on how to obtain both certifications, visit http://www.narte.org or call 800-896-2783. □

Dan Romanchik has a BSEE and 12 years of test engineering and engineering management experience. He has been covering the test and measurement and automotive industries for the past 14 years.

TRENDS

Communication technologies bring EMC challenges

Jon Titus, Contributing Technical Editor

Some engineers may consider EMC a topic past its prime, but emerging wireless technologies, coupled with the penetration of electronics products into developing countries, are giving the discipline new life. To meet the coming EMC challenges, though, the EMC expertise that's now primarily the domain of older practitioners must become available throughout the electronics industry.

To enhance EMC design prowess and encourage standards conformance, the International Electrotechnical Commission (IEC) has created the Advisory Committee on Electromagnetic Compatibility (ACEC). Its job, according to Dr. William Radasky, chairman of the ACEC, is to apply basic EMC standards to specific types of products.

The ACEC monitors and coordinates EMC standards that individual technical committees produce (**Figure 1**). The ACEC consults with the various technical committees so they can adopt reasonable and realistic standards. For example, suppose the committee that oversees standards for appliances needs to write an EMC standard for refrigerators. If the committee does not include an EMC expert, members of the ACEC can apprise it about efforts in other committees to handle related EMC problems (see "The IEC and EMC" on the Web at http://www.tmworld.com/emctr).

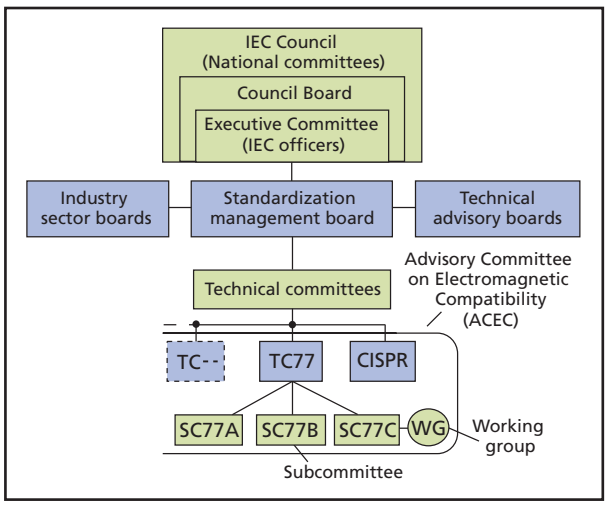

Fig. 1 Technical committees within the IEC establish the basic standards for EMI tests and compatibility. Technical committees may oversee subcommittees and working groups. The Advisory Committee of Electromagnetic Compatibility (ACEC) consults with all groups involved with EMC issues.

Wi-Fi and Bluetooth

Radasky sees problems with the mass use of wireless devices using Wi-Fi and Bluetooth technologies. Bluetooth—designed to eliminate cables between peripherals, intelligent appliances, and PCs—has a range of about 10 m. Wi-Fi (IEEE 802.11b) has more range—about 100 m—and is used to implement wireless local-area networks. Wi-Fi installations already provide Internet access in airports, hotels, and coffee shops. Although the market for portable devices is still small, the demand for short-range wireless devices will continue to grow, and as the number of units increases, so will EMC problems.

Although Bluetooth and Wi-Fi devices use different communication techniques and protocols, both types of devices use frequencies in the unlicensed industrial-scientific-medical (ISM) band at 2.4 GHz. Thus, they often end up interfering with one another in large office buildings in which hundreds of wireless devices are simultaneously transmitting (Ref. 2).

While most office equipment can easily tolerate bad packets caused by EMC problems, this is not the case for equipment used in hospitals and medical facilities. Designers of such equipment must more carefully analyze onsite frequency allocations and the implications of EMI and EMC.

At the new George Washington University Hospital (Washington, DC), for example, nurses will use wireless portable computers to chart patients' conditions, physicians will download x-ray images to laptop PCs, and staff members will use wireless devices to communicate by voice (Ref. 3). Facilities such as this may need to adopt their own frequency coordination to keep devices from interfering with one another, and to keep out "foreign" wireless devices brought in by patients, vendors, and visitors.

The IEC has established immunity requirements up to about 1 GHz, but above that, in the frequency ranges used by Wi-Fi and Bluetooth devices, the IEC has yet to develop tests that offer good repeatability. In the absence of such tests, engineers and users have to survey their environment and monitor signal levels to see what's going on at the frequencies they want to use or that could interfere with their equipment. That sort of empirical work may provide a snapshot of today's RF environment, but it may poorly represent a picture of future spectrum use. The EMC community will have to take precautions until the IEC develops standards and tests to cover the higher frequencies. Until now, frequencies above 1 or 2 GHz were the exclusive domain of military users and experimenters, yet commercial equipment and service providers see this "space" as ideal for the next genera-

tion of short-range communications devices. The EMC community, at least in the US, must put more emphasis on potential EMC problems—and solutions—at these higher frequencies.

Overall, the US EMC community seems to spend about 75% of its efforts on testing and regulating emissions, and about 25% of its efforts go toward identifying and fixing EMI and EMC problems. Radasky, who in addition to chairing ACEC works full time as the president of Metatech (Goleta, CA), a consulting company and after-market supplier of EMI filters, feels that many US product engineers don't fully understand immunity and emissions. Many of these engineers think they can overcome problems by simply reducing emissions, but in Radasky's opinion, they also must balance immunity and emissions to reach a compromise that works well when a user installs the equipment.

Radasky says that many industry leaders in the US seem uninterested in EMI and EMC problems, and that upper management isn't technical enough to understand the issues that can have an impact on a company's economic future. As an example of what dedication to EMC issues can achieve, he points to China, still a relatively new supplier of electronics equipment. Overall, Chinese manufacturers have surpassed their US counterparts, he said, having adopted over 50% of the IEC's applicable EMC standards, and they expect to comply with 100% of the standards within three years.

"Graying" of the experts

Companies that deal with emissions and immunity must also grapple with the "graying" of their experts and with the small number of EMC-inclined engineers entering the industry. According to Daryl Gerke of Kimmel Gerke Associates (Mesa, AZ), engineering schools concentrate on the glamorous topics of digital design and high-speed analog circuitry. Not many students show an inclination to the "pathology of electronics," as Gerke describes the study of EMC problems, causes, and cures. But the dearth of EMC and EMI training for undergraduates may stem from the lack of experience on the part of students. How can an engineering curriculum include a course on EMC when the students don't have enough design experience to understand the EMC problems and the answers?

At an IEEE EMC chapter meeting in Seattle, Dr. Howard Johnson, a high-speed digital-design consultant, observed a pronounced "baldness effect" among the male members of the group. He concluded most of them were getting close to retirement and that they had spent a lifetime educating themselves in EMC issues. He suggested that digital designers become obsolete after five to seven years, but EMC professionals go on and on (Ref. 4).

These people have gone through a "natural selection" that, according to Gerke, turned them into EMC experts more out of necessity and personal interest rather than as a career path sought in undergraduate or graduate school. Unfortunately, the lack of EMC experts stymies the push of newer technologies into the higher frequency bands, and it curtails the ability of companies to develop new products that can meet current and future immunity and emission standards. □

References

1. Gibson, Mark, "Market Trends: Clearing the Way for Wireless Medical Telemetry," *Comsearch*, May 2002. http://www.comsearch.com/newsletter/archiveWP/WirelessPulseMay02.html.

2. Lansford, Jim, Ron Nevo, and Brett Monello, "Wi-Fi and Bluetooth: Enabling Coexistence," *Compliance Engineering*, May–June 2001. http://www.ce-mag.com/archive/01/05/lansford.html.

3. Reel, Monte, "90 Feet and a World Away," *Washington Post*, August 21, 2002. p. B01.

4. Johnson, Howard, "Signal Integrity: Not all EMC engineers are bald," EDN, January 24, 2002. p. 26. http://signalintegrity.com/Pubs/edn/baldEngineers.htm.

Jon Titus has written real-time software and designed embedded systems and computer and instrument interfaces. He worked in electronics for 10 years and spent nine years at *Test & Measurement World* magazine and nine years at *EDN* magazine. He has a BS from WPI, an MS from RPI, and a PhD from VPI. E-mail: jontitus@attbi.com.

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PRODUCTS

Kit records resistance, temperature, humidity

The Surface Resistance Test Kit from Desco can simultaneously measure RTT, RTG, ambient temperature, and humidity, thereby reducing the number of instruments needed. The meter, which operates on two AA alkaline batteries, automatically selects the voltage range. Two 5-lb electrodes are included. *Desco, Chino, CA. 909-627-8178; http://www.desco.com.* **TIX 241**

Meter measures electrostatic voltages

The Model 542 accurately measures electrostatic voltages from 0 to ±20 kV. The instrument uses a DC-stable, electrostatic field chopper probe that can be remotely located. A large LCD screen displays information such as measured voltage and positive and negative peak voltages. *Trek, Medina, NY. 800-367-8735; http://www.trekinc.com.* **TIX 242**

Monitors ground workers, equipment

The 791W voltage wrist strap monitor simultaneously monitors the ESD voltages on two wrist straps and records ESD events in real time. The 791E equipment ground monitor provides three channels to continuously measure the ground connections of manufacturing equipment and ESD workstations. *3M, Austin, TX. 800-328-1368; http://www.3m.com.* **TIX 243**

Meter measures static dissipation

The 406D static-decay meter evaluates the performance of static-dissipative materials used in electronic component packaging and clean rooms. The instrument meets DOD, NFPA, and EIA requirements, and its calibration is traceable to NIST. *Electro-Tech Systems, Glenside, PA. 215-887-2196; http://www.electrotechsystems.com.* **TIX 244**

Hybrid amp delivers 10 W from 0.8 to 18 GHz

The Model 10ST1G18 is a self-contained, air-cooled amplifier that uses both solid-state and traveling wave tube (TWT) technology to deliver 10 W minimum from 0.8–18 GHz. Features include a GPIB interface; 0-dBm input; gain control; an RF output sample port; voltage standing-wave ratio (VSWR) protection; and monitors for TWT helix current, heater voltage, and cabinet temperature. *Amplifier Research, Souderton, PA. 215-723-8181; http://www.amplifiers.com.* **TIX 245**

Web resources

IEEE EMC SOCIETY

The site features electronic versions of the society's newsletter—which often includes technical articles—as well as job listings. It also includes information on the distinguished lecturer program, which provides speakers to local chapters. http://www.emcs.org.

WEB SITE AIDS ESD FLOORING SELECTION

Julie Industries' new site is designed to help architects, designers, and flooring contractors understand ESD control and to assist them in choosing the proper flooring materials. The Web site features an information library and an "Ask the Expert" column. http://www.julieindustries.com.

LEARN ABOUT THE IEC

A good introduction to the International Electrotechnical Commission's (IEC's) work in EMC can be found in the EMC Zone on the IEC's Web site. http://www.iec.ch/zone/emc/emc_entry.htm.