I E E E

Electromagnetic Compatibility Society

Newsletter

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SAN DIEGO

IEEE INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY

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A TRIBUTE TO THE 1986 EMC SYMPOSIUM COMMITTEE

The 1986 International Symposium on Electromagnetic Compatibility, sponsored by the IEEE EMC Society, was a huge success. Held in San Diego from September 16-18, it attracted nearly 2000 people who came from all over the world to hear more than 105 technical papers, attend informative workshops, enjoy entertaining luncheons and to see the wares displayed in 143 exhibit booths. Adding to its international flavor, most attendees of the CISPR meeting held during the prior week stayed to attend the Symposium. They also attended meetings conducted by the Society of Automotive Engineers (SAE) AE-4 Committee on EMC, the Electronic Industries Association (EIA) G-46 National EMC Committee, the American National Standards (ANS) C-63 S/C1 Committee, the dB Society and others.

It was a job well done by the Chairman, Herb Mertel, and a competent staff of organizing committee workers. The publicity, finances, technical papers and programs, exhibits, arrangements, registration, publications, hospitality and other activities were orchestrated in a manner that would inspire Wolfgang Amadeus.

The technical papers, the essence of the Symposium, were published in the Symposium Record. With the concurrence of the EMC Society Board of Directors, all members of the EMC-S will be receiving a complimentary copy of the Record within the next few months. This is financed largely by proceeds from this and other EMC-S Symposiums, exhibitors, patrons, and attendees. The hard work of many have made this all possible.

The next IEEE EMC-S Symposium will be held in Atlanta, GA on August 25-27, 1987. Society members will receive additional information automatically. Others should contact Hugh Denny at (404) 894-3535. There is no current plan to distribute the 1987 Symposium Record to members. Therefore, you should make arrangements to attend.

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EDUCATION COMMITTEE NEWS

The last issue of the newsletter contained a listing of colleges and universities having a course devoted to EMC. In this issue we detail one of these courses.

Dr. Clayton Paul of the University of Kentucky, Lexington, Kentucky, teaches a senior elective course, EE 599, Electromagnetic Compatibility. The course meets three times a week and consists of 43 one-hour lectures. In addition to the lectures, the course also consists of small laboratory experiments at the end of some of the topics. Perhaps one of the most important aspects of a course is the topic organization. Topics must be presented in an order such that they build on each other for reasons of efficiency and student understanding. The sequence of topics for this course is as follows:

COURSE OUTLINE

1. EMC OVERVIEW
2. EMC REQUIREMENTS
3. COMPONENTS
4. SIGNAL SPECTRA
5. RADIATED EMISSION
6. RADIATED SUSCEPTIBILITY
7. CONDUCTED EMISSIONS & SUSCEPTIBILITY
8. DIGITAL SYSTEMS DESIGN
9. CROSSTALK
10. SHIELDING
11. ELECTROSTATIC DISCHARGE

An important and unique aspect of the course is the inclusion of a student project. In order to generate student enthusiasm and involvement in the course, as well as to simulate the industrial experience, the students construct a simple digital device and test it for radiated and conducted emissions. Then using the materials learned in the course, they fix it for FCC compliance.

For additional information, contact Dr. Clayton Paul at the University of Kentucky at (606) 257-1644.

Henry Ott
Chairman, EMCS
Education Committee

AT&T Bell Laboratories
Room 1E-212A
Whippany, NJ 07981
(201) 386-6660

NEWSLETTER STAFF

INTER-SOCIETY ACTIVITIES

by Walt McKerchar

The SAE AE-4 Committee on Electromagnetic Compatibility advises that three new documents are now available from SAE Headquarters. They are "ARP 1700-Upper Frequency Measurement Boundary for the Evaluation of Shielding Effectiveness in Cylindrical Systems," "ARP 1792-Receiver Measurements, Practices and Procedures for EMC Testing," and "ARP 4043-Flight Lightning, Grounding and Bonding of Aircraft."

Copies of these documents are available by writing Mr. David R. Bentley, Aerospace Program Manager, SAE Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

The next meeting of the AE-4 Committee will be at the Chase Hotel in downtown St. Louis on March 17, 18 and 19, 1987. Contact the Chairman, Mr. Dwaine Awerkamp (M/S H2550, Motorola Inc., 8201 E. McDowell Rd., Scottsdale, AZ 85252 or phone (202) 949-3138) if you want to contribute to the committee activities.

The dB Society "sailed" into their 11th year of service to the EMC community at the recent IEEE EMC '86 Symposium in San Diego. They are complimented on their assistance to the General EMC '86 Committee, and especially with the registration activity at that Symposium.

The dB Society has extended their international relationship to include active groups in Great Britain and India. Groups are presently being formed in West Germany and Japan.

For those that may not be familiar with the dB Society, it is a fraternal organization of EMC engineers that have over ten years of active service in the EMC community. They do not engage in any technical activities, but enjoy service to the EMC community and support local charities in the location of the current IEEE International Symposia. The Society is not affiliated with any other professional technical organization. Inquiries may be directed to the Secretary, Mr. John E. Merrell, c/o Glenair Inc., P.O. Box 4434, Glendale, CA 91202.

POINT AND COUNTERPOINT

DOES IT REALLY MATTER, DOES IT REALLY?

by Anthony G. Zimbalatti

I am sure that you have attended meetings where your mind wandered from the subject at hand; mine did just recently. I kept thinking about the implications of a discussion in which a E^3 analyst, who was evaluating E^3 computer codes, told me that an evaluated code failed to provide a reasonable answer to a rather simple radiation coupling problem. That is, the expected leakage was to have a sinusoidal variation with angle. To his amazement, the leakage was essentially constant when he rotated the leakage path through 360° of angle! He called the code developer, who called back several days later and thanked the analyst for correctly identifying the faulted code. The analyst and I sort of mused about our experiences with such matters. We looked at one another and said, "Does it really matter? Who cares?"

Back at the meeting, I kept recalling that discussion, reminding myself that the code under evaluation has been used for several years and is currently being used on Department-of-Defense (DOD) programs. Then I recalled the answer of a user of that code when I asked this question: "Have you examined the accuracy of the solutions provided by the code?" I remembered being appalled when I heard, "Who

cares? The customer wants me to use the code, so why should I question the code?" Then I recalled the answer of an engineer involved with E^3 computer code development when I questioned that his code was erroneously treating certain problems. "Well," he replied, "There wasn't enough money to validate the code, we had to cut corners. So what? Who's going to check the details? Few people will know, less will care—that's old hat." I wondered, does it really matter?

Then I recalled a discussion with an engineer from Sweden after we had heard a talk presented by a scientist from the Washington, DC "Star Wars" Office, otherwise called "Strategic Defense Initiative (SDI)." He said to me, "You used to head the System Integration Group at Grumman. How would you like the job of integrating 1,000,000 subsystems?" Noticing my puzzled look, he said, "If one were to look at the computer codes as modules or subsystems, then look at the numbers of codes required to implement SDI, one could draw the analogy of integrating a large system with perhaps more than 1M software modules needing integration."

"WOW," I replied. The validation task of that integration would be horrendous, compounded by the fact that numerous modules are expected to use artificial intelligence to circumvent SDI countermeasures. Then I wondered, how many of the engineers working on SDI would view their codes like the engineers viewed the E^3 codes? How many unverified or unvalidated SDI codes would ensue? I thought of the implications of such a situation. And, I wondered, does it really matter? Who cares? Apparently, I was nudged a second time and told, "It's time to get your gold watch for 25 years of service." I kept wondering, does it really matter? Who cares?

1986 ELECTROMAGNETIC COMPATIBILITY SOCIETY BOARD OF DIRECTORS

From left to right: George Kunkel, Gene Knowles, Don Clark, Bob Haislmaier, Don Heirman, Bob Hofmann, Bob Goldblum, Henry Ott, Dick Ford, Len Carlson, Charlotte Tyson, Dick Shulz, Chet Smith, Fred Nichols, Risaburo Sato, Art Wall, Bob Brook, Gene Cory and Jim Hill.

EMC PERSONALITY PROFILE

by William G. Duff

MICHEL MARDIGUIAN

The IEEE EMC Society is truly an international organization and we have a number of members outside of the United States that are well known in the EMC community and that have made significant contributions. One such individual is Michel Mardiguian. Michel, an IEEE member, is Vice President of Interference Control Technologies, in charge of European Operations. He was born in Paris, France. After his graduation from Ecole Breguet (Paris) as an electrical engineer and his military service in the French Air Force, he joined "Marcel Dassault" Aircraft in 1965. Here, he worked on the electromechanical packaging of the Mirage "V," a vertical take-off version of the famous delta-wing fighter. In 1968 he moved to the south of France near Nice, working at the IBM R&D laboratory, mainly in the packaging of modems and computer-controlled PBXs.

At that time Michel was not involved in EMC, which was not yet a serious concern in computers. In 1974 he was offered the job of EMC specialist for his IBM site, a discipline for which he had no special inclination at first, and which was merely a matter of testing the equipment against company standards originated from IBM in the U.S. To get the proper training, he was assigned for 6 weeks at IBM Kingston, NY, which had a strong concentration of EMC talent. He worked with A. A. Smith Jr., Ralph Calcavecchio and R. D. Simonic, learning from them the ABCs of EMC analysis. He then moved back to France where he started to apply his fresh new skills to the products under design, while working in parallel on some self-initiated projects, like attenuation comparison between IBM free-field test sites and EMC test of large objects.

In 1976 he was appointed French delegate to the CISPR Working Group on computer interference, where he participated actively for four years on what would later become CISPR Publication 22 and would have a great influence on the FCC Part 15 — Subpart J.

In Nov. 1980 Michel left IBM for Gainesville, VA, to join Don White Consultants, Inc. as Training Director. He helped to enlarge the menu of EMC application seminars and taught more than 100 courses in 5 years, in the U.S. and worldwide. He wrote or co-authored several Handbooks on "EMI Control in Computers," "EMC Methodology and Procedures," and "ESD." He also generated several practical prediction models for printed-circuit board radiated emission, coaxial cable crosstalk and shielded pair differential transfer impedance for which he also conducted validation tests.

Michel has published five papers at IEEE/EMC and Zurich symposia and has written seven articles on EMC for several magazines. Michel is also very fond of Traditional Jazz and Middle-Jazz, being himself a very active clarinet player since 1961. He has been a member of several famous groups in France and in Washington, DC and, as a band leader, has recorded two LPs.

PRACTICAL PAPERS, ARTICLES, AND APPLICATION NOTES

by Edwin L. Bronaugh

When I received this paper for publication in the Practical Papers department, I thought at first that it might not be appropriate. But after much thought and a conference with the Newsletter Editor, I realized that this is indeed a practical paper. Mr. Rock makes some good points and asks us as EMC professionals to do our professional duty and keep our government out of trouble. Mr. Rock would be pleased to receive your comments and thoughts on how to assure *adequate* EMC in the face of the DOD ASI program.

THE DOD ASI PROGRAM AND EMC

By Frank E. Rock, EMC Engineer
Building 102/078
9500 Godwin Drive
Manassas, VA 22110
Telephone (703) 367-2603

SUMMARY

The Acquisition Streamlining Initiative or ASI program appears to be a serious effort on the part of the Department of Defense to reduce military program costs and merits consideration by the EMC community, especially those professionals involved with military EMC. My purposes for writing this article are as follows:

1. To introduce ASI to the EMC community. Note that ASI information has been publicly widely distributed at program manager levels[2][3] throughout the United States, but not to the EMC community at large.
2. To get the attention of the ASI authorities so that they will not neglect EMC.
3. To stimulate needed correlation between the military EMC specifications (MIL-STD-461/462, etc.) and commercial specifications (FCC, VDE, CISPR, etc.) so as to facilitate the utilization of commercial equipment by the military to a much greater extent than at present, thereby saving the U.S. Government millions of dollars.

Definitions:

1. ASI—Acquisition Streamlining Initiative.[1]
2. DOD—Department of Defense
3. EMC—Electromagnetic Compatibility
4. Steamlining—Any action taken (including risk) to prevent or eliminate non-cost-effective government requirements.

DISCUSSION

It is not news that the Department of Defense wants to reduce the costs of military programs and get more bang for the buck. What is news is that with the cooperation of industry they are creating a mechanism to break away from the presently encumbered system of military acquisition and it is called the ACQUISITION STREAMLINING INITIATIVE or ASI program.

This appears to be a very serious effort on the part of the Department of Defense to reduce cost and they are holding meetings around the country to spread the ideas. A DOD Directive 4120.21, "Acquisition Streamlining,"[1] has been redrafted and is being reviewed. It cuts across the entire acquisition process and is based on the concept that they can save costs by avoiding the premature application of contract requirements via the standard specifications family trees. It is not the same as the "Skunk Works" concept but incorporates some of its ideas. In addition, MIL-HDBK-248, "Guide For Application And Tailoring Of Requirements For Defense Material Acquisitions," is being updated to reflect the directive.

An ASI DOD policy goal is to insure that contract requirements result from intent and not accident. It has been found that a leading contributor to the accidental incorporation of unncessary or counterproductive contract requirements has been caused by the failure to place a limit on the contractual applicability of documents referenced in the specifications and standards. The avoidance of the premature application of military specifications and standards and the limitation of

inadvertent, indirect referencing of contract requirements is DOD policy.

The implementation of this DOD policy will require the following procedures:

1. Initial Development: System level requirements are to be specified in mission performance terms. Military standards and specifications are to be evaluated and, if required, shall be tailored for application to full scale development.
2. Full-Scale Development Contracts: Limit contractual applicability of specifications, standards and related documents to those cited in the contract (no second tier indirect referencing).
3. Production Contracts: Only those specifications cited in the baseline shall be considered for production procurement and reprocurement purposes.

Note that the ability to specify in terms of mission performance will require the utilization of greater expert resources during the initial development so as to avoid the specification "boiler plate" approach.

Some of the programs targeted by DOD for streamlining are identified in the following listing:

ARMY
- Experimental Light Helicopter
- Advanced Anti-Tank Weapon
- Family Of Medium Tactical Vehicles
- Joint Tactical Missile System
- Light-Weight Air Defense System
- Armored Gun System

NAVY
- Undergraduate Jet Flight Training System (T-45)
- Joint Services Advanced Vertical Lift Aircraft Program (V-22)
- Replacement Inner Zone Air ASW Vehicle (CVIZ Helo)
- Amphibious Assault Ship (Multipurpose)
- AE36 (Ammunition Ship)
- Patrol Combatant Multi-Mission Ship
- Advanced Tactical Aircraft
- World Wide Info System (WIS) Modernization
- Afloat Correlation Program
- EHF SATCOM
- Relocatable Over-The-Horizon Radar
- Ship Launched Electronic Decoy
- RP3D Research Aircraft
- VH-60 Presidential Helicopter

AIR FORCE
- Advanced Tactical Fighter
- Integrated Electronic Warfare System
- World Wide Info System (WIS) Modernization
- Advanced Medium Range Air-to-Air Missile Production Program
- Advanced Tactical Fighter Engine
- PEACEKEEPER ICBM Program
- Accelerated Small ICBM Program
- MILSTAR
- Local On-Line Networking System
- Joint Surveillance Target Attack Radar System
- Anti-Radiation Missile Decoy
- Titan T34D7 Space Booster
- Air Force Mini-Computer System

It is not clear what effect ASI will have on EMC. There is concern within the EMC community that ASI may cause great harm. For years we have been preaching that EMC needs to be considered during the early development phase, but now ASI could be interpreted as delaying that. I, however, do not think ASI is saying that, but rather is requesting requirements be stated in terms of mission needs and not by "boiler plating" specifications without evaluation and tailoring. EMC specification tailoring is not new. MIL-E-6051D, "Electromagnetic Compatibility Requirements, Systems," itself states in paragraph 3.2C that since some of the limits of MIL-STD-461 are severe, limit modifications should be proposed when system effectiveness, cost and weight are impacted.

The ASI approach has stimulated thoughts. One area where this DOD program may do some good is in the utilization of Commercial Off The Shelf (COTS) equipment in places where MIL-hardened items are not really required. There are procurements where this is done to some extent. However, they very often defeat the cost-saving potential by applying military specifications or standards, such as MIL-STD-461/462, to COTS. MIL-E-6051D states in paragraph 3.4 that COTS equipment may be considered adequate (for military use) if system requirements are not significantly more stringent than those to which the equipment was designed and for which interference test reports are available to demonstrate compliance. It states further that compliance does not relieve the contractor of providing system compatibility (a risk reduction factor).

The problem is that there is no easy way for acquisition personnel to compare commercial EMC technical standards, such as FCC, VDE, and CISPR for emission, and ANSI and IEEE for suceptibility, against MIL-STD-461/462 requirements. They do not have the expertise or resources to do so at the time required and, therefore, to minimize risk, there is no choice but to invoke MIL-STD-461/462 on commercial equipment (already certified to FCC requirements).

It is therefore suggested that the EMC community provide leadership and make the job easier by preparing such a comparison to be used as resource material by cognizant government EMC and procurement authorities to facilitate the correlation of FCC and MIL-STD-461/462 test data, thereby providing the bases for greater judgemental accuracy, realistic cost savings and better EMC.

Frank E. Rock is an EMC, EMP, and TEMPEST Engineer of many years. He is a frequent contributor of EMC articles and instructs courses in MIL-STD-461 and MIL-STD-462. He has a BSEE from Rutgers University and has graduate credits. He is a senior member of the IEEE and belongs to the EMC Society. He is also a member of the EIA G-46 EMC Committee. He is a licensed, general class, commercial radio telephone operator and his amateur radio station call sign is WA4HAI.

REFERENCES

(1) DOD Directive 4120.21, Acquisition Streamlining Initiative.

(2) Journal of the Defense Management College, *Program Manager*, Jan-Feb and March-April, 1985 issues.

(3) Electronic Industries Association (EIA) *Engineering News*, July/August 1985 issue.

BOOK REVIEWS

by Jim Hill, The EMXX Corp.

With the electrostatic discharge season upon us it is timely to review a book which treats this subject in detail. We are indebted to Bill Duff for the review of this book by EMC Society member Michel Mardiguian.

For the second book review we credit James Wait, also an EMC Society member, who recently moved from the National Bureau of Standards, Boulder, to join the Department of Electrical and Computer Engineering of the University of Arizona. His review of *Antennas and Radiowave Propagation* first appeared in the Antennas and Propagation Society Newsletter.

As we are writing this column in August we have just received a supply of the *Eighth International Wroclaw Symposium on EMC Proceedings.* This has been printed in 3 volumes with a total of 1190 pages. The program contained 127 papers, some in English and some in Russian. In each case there is a summary in the alternate language. These are available for shipment now. The price is $30.00 postpaid in the U.S.A. and Canada. Orders from other parts of the world should be handled through the Wroclaw EMC Committee. Checks should be made out to the IEEE EMC Society and the order sent to me at the EMXX Corp., 6706 Deland Drive, Springfield, VA 22152. We plan to do a review of this Wroclaw Symposium *Proceedings* in our next Newsletter issue.

ELECTROSTATIC DISCHARGE — UNDERSTAND, SIMULATE AND FIX ESD PROBLEMS

Michel Mardiguian
Interference Control Technologies, Inc.
Gainesville, VA, 1985

For decades, people have been learning the hard way that statics can cause explosion of fuels and ammunitions. In 1937, the German flying ship *Hindenburg* caught fire while mooring at its landing mast. The resulting fire caused the death of 38 of its hundred or so passengers. Although the causes have not been completely understood, electrostatic discharge (ESD) is on top of the list. More recently, during the 1970's in the U.S., a spacecraft launching rocket exploded during fueling operations, killing three engineers. The cause was, beyond any doubt, identified as ESD.

Although such catastrophes are terrible and spectacular, they are quite rare. A more insidious aspect of ESD bloomed in the early 1970's with the arrival of integrated microelectronics. The plants producing integrated circuits started to experience disappointing percentage yields. Once thoroughly investigated, the problem was found to be mostly ESD during all fabrication steps and handling. With the proliferation of microelectronics, a number of complaints flourished about erratic errors, transient malfunctions, erased memory, etc. Although the economic losses represented by erroneous transactions and corrupted data of all kinds is difficult to evaluate, it is probably an even bigger figure than the one for chip damage during fabrication.

This book on electrostatic discharge addresses the problems encountered in modern electronics equipment as a result of electrostatic discharge. The first chapter reviews briefly how static electricity takes place, what the contributing parameters are and why it results abruptly in an electrostatic discharge.

Chapter Two describes the mechanisms by which ESD can be injected into electronic devices. The three mechanisms described are:

- Direct discharge to an electronic component (integrated or discrete);
- Direct discharge to an electronic equipment housing;
- Indirect discharge.

This chapter also describes how the transients are coupled into circuitry and discusses the response of victim circuits to these transients.

The third chapter describes ESD specifications which are used to define requirements for immunity of electronic circuits, components and equipments to ESD. Chapter Four describes ESD test instrumentation, test methods and procedures for diagnosing ESD problems. Chapter Five presents design procedures that may be used to provide immunity to ESD. Protection against ESD can be implemented in one or more of the following stages:

- at component level
- at circuit board level
- by software and noise inhibition features
- at internal packaging and wiring level
- at housing/cabinet level
- at external cabling level
- at installation and environment level

Chapter Six relates some ESD "war stories" experienced mostly by the author himself or by his associates at an interference control consulting firm in the U.S. There are periods when the telephone rings several times a day just for ESD calls. Assisting a customer who has an ESD problem is seldom a boring, "deja vu" experience. Of all the EMI manifestations, ESD is probably the one whose symptoms can be the most varied and deceptive and whose diagnosis can be the

most elusive. Needless to say, ESD is also a privileged area for Murphy to exercise his laws with demoniac ability.

In summary, this is a well written informative book which provides information that will help the reader understand, simulate and fix ESD problems. It should be considered by anyone involved in ESD design.

Reviewed by:
William G. Duff

Atlantic Research Corp.
5930 Cherokee Avenue
Alexandria, VA 22314

ANTENNAS AND RADIOWAVE PROPAGATION

Robert E. Collins
McGraw-Hill, New York, 1985, xii + 508 pages.
$49.95. ISBN 0-07-011808-6

It is a pleasure to have the opportunity to review this timely book by Professor Collin. While there has been no lack of antenna texts in the past few years, including two massive handbooks, none of these really address the communication aspects. Also books on propagation have been few and far between. Thus, there was a crying need for a reasonable length book that covered antennas and propagation from a communication standpoint. Another goal set by the author was to present the material in both a reference format and as lecture notes for undergraduates. It is premature to say if all these objectives have been met.

Naturally enough, the book is divided into two parts; I covers antennas and II covers propagation. In Part I the author begins with a nifty little chapter on communication concepts and relative roles of antennas and propagation in the overall system development. A very succinct development of electromagnetic fundamentals then follows. The latter would be tough sledding for any undergraduate unless he had already had a separate undergraduate field course (e.g. the relationship between Pocklington's and Hallen's integral equations is not for the faint-hearted). The method of moments is also outlined where Professor Collin points out that the Soviets were onto this technique in the period 1925-1926 (e.g. see Kantorovic and Krylov, *Approx. Methods of Higher Analysis,* Wiley, 1958). In this same chapter the reader will find a very profound discussion of integral equation formulations for linear antennas, including some provocative comments about the numerical handling (and mishandling) of the approximated integral equation.

The next two chapters cover dipoles, arrays, long wire antennas and aperture type antennas (in 220 pages). Much of this material is to be found in other texts such as Elliott, Rudge et al., Balanis, Jull, Popovic, Jasik and Johnson and Thiele and Stutzman, just to name a few. But the material is nicely done with many good problems. The next chapter covers the receiving antenna and this portion of the book fills a need for anybody who is going to design a communication system where such things as polarization mismatch and antenna noise temperature must be considered.

The propagation part of the book was of special interest to this reviewer, as he has felt for some time that a good book on propagation is badly needed. Professor Collin, in a scant 115 pages, has covered a large segment of the subject in a consistently scholarly style. He presents a terse development of the ground reflection problem and shows, using geometrical optics, how the Fresnel reflection coefficients can be used to estimate the interference pattern of the direct and reflected rays. However, he seems to have the wrong sign on the phase angle (i.e. according to eqn. 6.8a, the phi should be minus that shown in Fig. 6.5). This has a bearing on eqn. 6.12 for the total field. There is a nice discussion of the divergence of rays being reflected at the spherical earth boundary. Related radar coverage diagrams are then presented following closely the pioneering work of Kerr, Burrows and Atwood from the late 1940's. As the author indicated, things get sticky when the line connecting transmitting and receiving antennas just graze the earth's surface. Here he might have mentioned many more recent studies of this problem which are based essentially on the celebrated Fock integrals. In fact such results are now available in engineering format in both the Soviet and Western literature.

Professor Collin's discussion of the famous Sommerfeld dipole-over-the-half-space problem is neat and to the point. However, the recipe for handling the spherical earth correction seems very crude particularly by his high standards. His reference to Terman's 1943 Handbook caused the reviewer some bewilderment. The gross interpolation, between the flat earth formulas at short distances and the single term of the residue series valid deep in the shadow, is a museum piece. Now it is considered standard practice (e.g. CCIR) to use the full Van der Pol-Bremmer-Pekeris-Wwedensky-Fock etc. results (see Rotheram, *Marconi Review,* vol. XLV, pg. 18, 1982 for a convenient set of computed ground wave curves which also take earth curvature and normal atmospheric refraction fully into account). but maybe some people still prefer to use the older methods and Professor Collin has certainly summarized the well tested procedures very well.

The book includes some very good examples of propagation system type calculations using results from papers widely dispersed in the journal literature. He has unified and condensed much of the currently available information in this regard. For example, he has presented the basic theory of ELF and VLF transmission in the earth-ionosphere waveguide. There are a few places where minor inaccuracies or mis-statements occur (for example, the 'near zone' fields of a horizontal electric dipole given by 165a-c). The results for the fields are only valid at distances large compared with the wavelength in the earth as can be gleaned from the reviewer's 1961 paper cited by Hasserjian and Guy. On page 434, there is comment that ground conductivity plays a minor role in determining the propagation constant of the modes in the very low frequency earth-ionosphere waveguide. This, of course, is not true. In spite of the relative smallness of the ionospheric conductivity, the reflection mechanism is more dielectric-like than the lower boundary which is metallic-like. The respective reflection coefficients are then roughly –1 and +1.

My overall impression of the book is very good. It is a must

(Continued on page 10)

for anybody who is concerned with the propagation channel in their systems calculation.

Reviewed by:
James R. Wait

Dept. of Electrical & Computer Engineering
The University of Arizona
Tucson, AZ 85721

FUTURE EMC-S SYMPOSIA SCHEDULE

1986 — San Diego, CA; September 16-18
Town & Country Hotel
Herbert K. Mertel
(619) 578-1480

1987 — Atlanta, GA; August 25-27
Marriott Downtown
Hugh W. Denny
(404) 894-3535

1988 — Seattle, WA; August 2-4
Westin Hotel
Donald A. Weber
(206) 575-5781

1989 — International
Japan
Drs. Akao & Sato
0565 48-8121

— National
Denver, CO; May 23-25
The Radisson
John Adams
(303) 497-3328

1990 — Washington, DC; August 21-23
Washington Hilton
Thomas W. Doeppner
(703) 664-3477

1991 — New Jersey, August
Donald N. Heirman
(201) 834-3566

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Issue date: Summer 1986 (TH0148-7) Booklet No. 1

How To Write An Invention Disclosure
Issue date: Winter 1986 (TH0149-5) Booklet No. 2

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EMC-86 COLLOQUIUM *PROCEEDINGS* AVAILABLE

The Santa Clara Valley Chapter of the IEEE's Electromagnetic Compatibility Society held an EMC colloquium, EMC-86, on April 29 and 30, 1986. Papers were presented on a wide variety of subjects, including measurement and analysis, materials, standards and regulations and case studies.

Papers were presented by a number of well-known experts in EMC, including Scott Bennett of Hewlett-Packard, Chris Kendall of CK Consultants, Donald Heirman of AT&T Information Systems and Henry Ott of AT&T Bell Laboratories. Copies of the EMC-86 *Proceedings* are still available for $20.00 in the U.S., $25.00 overseas. Please send payment to Ghery Pettit, Secretary, Santa Clara Valley Chapter, IEEE EMC Society, Tandem Computers, Inc., 2550 Walsh Avenue, Santa Clara, CA 95051.

FIELDS DIVISION PUBLICATIONS

For many years the NBS Electromagnetic Fields Division (and its predecessors) developed measurement methods and standards and provided metrological support for those involved in measurements of microwaves; antenna systems; electromagnetic noise, emission, immunity, susceptibility and interference; non-ionizing radiation and waveform metrology.

A bibliography of the Division's publications from 1970 through September 1985 has been compiled and is now available. Order *A Bibliography of the NBS Electromagnetic Fields Division Publications* (NBSIR 85-3040) from the National Technical Information Service, Springfield, VA 22161, for $11.95 prepaid. (Order by PB#86-191947).

1987 IEEE AP-S INTERNATIONAL SYMPOSIUM AND URSI RADIO SCIENCE MEETING

The 1987 International Symposium and Radio Science Meeting, sponsored jointly by the IEEE Antennas and Propagation Society (AP-S) and by USNC Commissions A and B of the International Union of Radio Science (URSI), will be held at Virginia Polytechnic Institute and State University, Blacksburg, VA, on June 15-19, 1987. The technical sessions for IEEE AP-S and URSI will be coordinated to provide a comprehensive and well-balanced program. Authors are invited to submit papers on all topics of interest to the AP-S and URSI membership. The topics listed below are intended as suggestions; consideration will be given to papers on other subjects.

All summaries and abstracts of papers must be received before January 2, 1987. The Digest will be produced directly from the author's original, so typing and layout instructions must be followed closely. Failure to comply with the instructions will result in the rejection of the paper. There are specific detailed instructions for all authors, with additional instructions for AP-S and URSI authors. If the authors wish the Technical Program Committees to decide whether the paper is more suitable for AP-S or for URSI, papers should be submitted in both formats.

All questions concerning the technical program and all papers should be directed to Charles W. Bostian, Technical Program Chairman, IEEE AP-S/URSI Symposium, Department of Electrical Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, telephone (703) 961-6834. Questions about other aspects of the Symposium should be directed to Warren L. Stutzman, General Chairman, Department of Electrical Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, telephone (703) 961-6835.

SUGGESTED TOPICS FOR AP-S

Adaptive antennas
Antenna measurements and metrology
Antenna theory
Environmental effects on waves
Feeds and radiating elements
Microstrip antennas
Millimeter waves
Numerical methods
Phased arrays
Propagation
Reflector antennas
Remote sensing
Scattering and diffraction
Wave-propagation theory

SPECIAL TOPICS FOR AP-S

Affordable high-performance antenna design
Antennas for small earth stations
Imaging radar antennas
Impact of computer architecture and supercomputers on EM computation
Innovative techniques in teaching electromagnetics
Monolithic antennas and MMIC technology
Personal computers in EM education and engineering practice
Using optics in antenna technology

SUGGESTED TOPICS FOR URSI

Commission A (Electromagnetic Metrology)
- EM measurements using satellites
- Field and antenna measurements
- Microwave and millimeter wave measurements
- System identification measurements
- Time domain measurements

Commission B (Field and Waves)
- Antenna theory
- EM theory
- Guided waves
- Inverse scattering
- Numerical techniques
- Random/nonlinear media
- Scattering and diffraction
- Transient fields

SPECIAL TOPIC FOR URSI

Phase-space techniques in wave propagation

INSTRUCTIONS FOR ALL AUTHORS

All papers must be written in English. Both the address and covering letter should clearly direct the manuscript to the 1987 AP-S Symposium or the URSI Radio Science Meeting. The text should be typed **single space** on white 8½ x 11 paper (21.5 x 28 cm). The title should be centered in **capital letters one inch** from the top of the first page. The author's name and complete organizational affiliation should be *two lines below the title* and the text should start **three lines below this.** Left and right-hand margins should be **1½ inches.** A **1-inch margin** should be left at the **top** and **bottom** of all pages. **Double space** between paragraphs.

ADDITIONAL INSTRUCTIONS FOR AP-S AUTHORS

The summary is to be limited to four pages including all text, references, figures and photographs. The original and three copies of the summary must be submitted in final form. Since there will be a reduction of about 72% in linear dimensions, letters and symbols in all diagrams should be sufficiently large and clear. Figures and photographs (in glossy prints) should be a convenient

size and affixed on 8½ x 11 paper with captions typed in appropriate places. Footnotes should be used except for credits to sponsoring agencies; papers will be considered only if they have been fully cleared by the sponsoring agency.

ADDITIONAL INSTRUCTIONS FOR URSI AUTHORS

The abstract should be as complete as possible, but must be limited to one page, including figures. Since there will be a reduction of about 72% in linear dimensions, letters and symbols in all diagrams should be sufficiently large and clear. Do not include lists of references; a few open literature references may be included parenthetically, for example (J. W. Smith, Radio Sci. 22, 453-461, 1987). The original and three copies of the abstract should be submitted, stating Commission preference. Acknowledgement of financial support is not deemed appropriate.

COMPUMAG CONFERENCE ON COMPUTATION OF ELECTROMAGNETIC FIELDS

The sixth COMPUMAG Conference on the Computation of Electromagnetic Fields will be held at the Conference Center in Graz, Austria, August 25-28, 1987. Its aim will be to review recent developments in the analysis of electromagnetic fields for physicists and engineers engaged in the design of electromagnetic devices and permanent magnets. Previous COMPUMAG Conferences were held at Oxford (1981), Grenoble, France (1978), Chicago, U.S.A. (1981), Genoa, Italy (1983) and Fort Collins, Colorado, U.S.A. (1985).

The principal objective of the conference is to discusss practical applications of numerical techniques to compute magnetic fields. Reflecting the growing importance of coupled problems, it is intended to feature papers on electromagnetic fields coupled to mechanical, electronic, thermal and/or flow systems. In order to present an overview and focus attention on future trends in areas of immediate as well as long term interests to the conference, prominent speakers will be invited to present papers. Preliminary short versions of papers are due at the Conference. The Conference Proceedings will be published in the IEEE Transactions on Magnetics.

Topics of interest to the Conference include:

1. Two and three dimensional magnetostatic and electrostatic field calculations for both linear and non-linear problems. Both new techniques and improvements to existing methods are appropriate subjects.
2. Time-dependent fields, including the transient and steady state behavior of electromagnetic devices, eddy currents, flux penetration into iron and equivalent circuit techniques.
3. Material properties, including the numerical treatment and anisotrophy, hysteresis, permanent magnets and diamagnetics.
4. Electromagnetic fields coupled to a mechanical, electronic, thermal and/or flow system. Examples include actuators, variable speed drives, superconducting magnets, electroheat, nondestructive testing, recording heads, nuclear fusion and power electronic devices.
5. Numerical techniques, including mesh generation, optimization and methods of solving large sets of equations with dense or sparse matrices of coefficients.
6. Practical experience in the application of computer programs for the design of electomagnetic devices, with a particular reference to the calculation of forces and other terminal parameters.
7. Software methodology and interactive computer aided design for electromagnetics. Topics of interest include graphics, parallel computation, knowledge base, expert systems and AI-techniques.

An on-line computer display and exhibition of both commercial and university/research organizations is planned during COMPUMAG 87. For further information, contact K. Preis, M. Königswieser, INTERCONVENTION, P.O. Box 80, A-1107 Vienna, Austria.

EMC CONFERENCE IN BANGALORE, INDIA

The International Conference & Workshop on Electromagnetic Interference & Compatibility (INCEMIC) will be held on September 10 and 11, 1987, in Bangalore, India. The Conference will be preceded by a three-day workshop on September 7, 8 and 9. The Committee is issuing a Call for Papers for original work in the following and related fields: a) EMC analysis, b) EMC design and case histories, c) spectrum management, d) EMI coupling in cables and interconnects, e) EMI in communication systems, f) EMI measurements and measuring systems, g) EMP and related topics and h) transient/electrostatic discharge.

Those intending to present a paper at the Conference should send a 100-word abstract and a 500-word summary to: Dr. G. K. Deb, Electronics and Radar Development Establishment, Bangalore-560 001, India in time to be received December 1, 1986. Notification of acceptance will be by February 1, 1987 and the last date for submission of camera-ready manuscripts is June 1, 1987.

The workshop/tutorials will cover EMC in digital circuits, EM coupling problems and transient supression techniques. Those interested in attending the Conference and/or the tutorials should contact: Dr. G. R. Nagabhushana, Convener, INCEMIC, Department of High Voltage, Indian Institute of Science, Bangalore-560 012, India.

1987 NATIONAL RADIO SCIENCE MEETING

The 1987 National Radio Science Meeting will be held on January 12-15 at the University of Colorado, Boulder, CO. This open scientific meeting is sponsored by the U.S. National Committee for the INTERNATIONAL UNION OF RADIO SCIENCE (URSI). It is being held in cooperation with the following IEEE societies: Antennas and Propagation, Circuits and Systems, Communications, Geoscience and Remote Sensing, Information Theory, Instrumentation and Measurement, Microwave Theory and Techniques, and Nuclear and Plasma Sciences.

Papers have been accepted on topics of interest to the commissions listed below as well as the special topics listed. The names of organizers of special sessions are in parentheses. The advanced program, including information on accommodations, will be published at the end of November. For more information, contact Professor S. W. Maley, Chairman, Steering Committee, National Radio Science Meeting, Department of Electrical Engineering, University of Colorado, Boulder, CO 80309. For additional information on the technical program, contact Chalmers M. Butler, Technical Program Committee Chairman, National Radio Science Meeting, Clemson University, Clemson, SC 29634-0915, or telephone (803) 656-5922.

COMMISSION A: Electromagnetic Metrology Chm.: H. M. Cronson (617) 271-6917	Antenna & EM Field Measurements (Motohisa Kanda) Time Domain Measurements (Edmund K. Miller) Integrated Circuit Measurements EM Measurements using Satellites EM Measurements in Biology
COMMISSION B: Fields and Waves Chm.: A. Ishimaru (206) 543-2169	Scattering and Diffraction Transient Fields Numerical Techniques Inverse Scattering Antennas and Arrays Random Media
COMMISSION E: Electromagnetic Noise and Interference Chm.: J. M. Morris (202) 636-6688	Characterization, Measurement, and Modeling of Noise and Interference Performance of Systems and Non-Gaussian Environment EMP
COMMISSION F: Remote Sensing and Wave Propagation - Neutral Atmosphere, Oceans, Land, Ice Chm.: R. K. Moore (913) 864-4832	Earth-Space Propagation Tropospheric Propagation Radio Meteorology Propagation in the Ground
COMMISSION G: Ionospheric Radio and Propagation Chm.: K. C. Yeh (217) 333-8125	Auroral and Polar Cap Irregularities (Sunanda Basu) Global Ionospheric Variations (Robert W. Schunk) Ionospheric Radio Techniques (Bodo W. Reinisch) What is There Left to Study about the Ionosphere and Why? (J. A. Klobuchar) World-Wide Acoustic Gravity Wave Study (Paul E. Argo) ELF/VLF Radio Wave Propagation (joint with H) (A. C. Fraser-Smith) Ionospheric Modification (joint with H) (Lewis M. Duncan)
COMMISSION H: Waves in Plasma Chm.: K. J. Harker (415) 497-1382	Wave, Particle, and Mass Injections in Space Plasmas (W. W. L. Taylor) Plasma Chamber Simulation of Space Phenomena (R. Stenzel) RF Acceleration of Particles in Space (K. Papadopoulos) Ionospheric Wave Experiements from the Space Station (R. Post)
COMMISSION J: Radio Astronomy Chm.: W. J. Welch (415) 642-6679	Data Management: Storage, Recording Devices Signal Processing: Spectrometers, Correlators, Pulsar Detectors Future Instrumentation: Detectors, Space/Lunar Based Antennas Millimeter and Submillimeter Wave Techniques: Detectors, Antennas, Optics, Spectrometers, Image Processing

CALENDAR
1986

September 29-October 3

5th Int'l Conference on EMC
University of York, England
Contact: Mr. R. Larry
IERE
99 Gower St.
London, WC1E 6AZ England
01-388-3071

October 27-29

IEEE Holm Conference on Electrical Contacts
The Copley Plaza, Boston, MA
Contact: IEEE Holm Registrar
IEEE Components, Hybrids, and
Manufacturing Technology Society
345 East 47th Street
New York, NY 10017

November 4-6

6th Int'l Conference
Israel Society for Quality Assurance
Tel-Aviv, Israel
Contact: Conference Secretariat
Ortra Ltd.
2 Kaufman Street
P.O. B. 50432
Tel-Aviv 61 500, Israel
Telephone: 03-664825
Telex: 361142

CALENDAR
1987

January 12-15

1987 Radio Science Meeting
University of Colorado
Boulder, CO
Contact: Professor S. W. Maley
National Radio Science Meeting
Department of Electrical Engineering
University of Colorado
Boulder, CO 80309

March 3-5

7th International Zurich Symposium &
Technical Exhibition on EMC
Zurich, Switzerland
Contact: Professor Dr. T. Dvorak
ETH Zentrum-IKT
8092 Zurich, Switzerland
Telephone: (411) 256-2790
Telex: 53178 ethbi ch.
In U.S.A.: R. M. Showers
(215) 898-8123

April 21-23	22nd Annual High Frequency Power Conversion Conference '87 Crystal Gateway Marriott Washington, DC Contact: Sam Davis, Technical Director HF Power Conversion '87 2472 Eastman Avenue Building 34 Ventura, CA 93003 Telephone: (805) 658-0933 Telex: 182218 pci vent.
August 25-28	COMPUMAG 87 Conference on the Computation of Electromagnetic Fields Graz, Austria Contact: K. Preis, M. Konigswieser INTERCONVENTION P. O. Box 80 A-1107 Vienna, Austria
June 15-19	1987 IEEE Antenna and Propagation Society Symposium and International Union of Radio Science (URSI) Meeting Virginia Polytechnic Institute and State University Blacksburg, VA Contact: Warren L. Stutzman Department of Electrical Engineering Virginia Polytechnic Institute and State University Blacksburg, VA 24061 Telephone: (703) 961-6835
August 25-27	IEEE International Symposium on EMC Marriott Downtown Atlanta, GA Contact: Hugh W. Denny Telephone: (404) 894-3535
September 7-9	INCEMIC Workshops (see below)
September 10-11	International Conference on EMI & Compatibility (INCEMIC) Bangalore, India Contact: G. R. Nagabhushana Convener, INCEMIC Department of High Voltage Indian Institute of Science Bangalore-560 012, India

INSTITUTIONAL LISTINGS

The IEEE Electromagnetic Compatibility Society is grateful for the assistance given by the firms listed below and invites application for Institutional Listings from other firms interested in the electromagnetic compatibility field.

ELECTRO-METRICS, Division of Penril Corp., 100 Church St., Amsterdam, NY 12010
Telephone (518) 843-2600
EMI Meters/Spectrum Analyzers/Systems Incl.; Computer Control— 20 Hz-40 GHz/TEMPEST & ESD Instruments.

RADIATION SCIENCES, INC., 3131 Detweiler Rd., Harleysville, PA 19438
Telephone (215) 256-4133
TEMPEST/EMI/EMC/FCC; FULL Engineering and Support Services: Testing, Design, Documentation.

SPECTRUM CONTROL, INC., 2185 W. 8th St., Erie, PA 16505
Telephone (814) 455-0966 TWX: 510-699-6871
Complete EMC: FCC/MIL Consulting, Testing, Repair, Mfr. RFI Filters, RFI Gaskets, D-Subminiature Connectors.

LECTROMAGNETICS, INC., 6056 W. Jefferson Blvd., Los Angeles, CA 90016
Telephones (800) 325-9814 (213) 870-9383
RF shielded enclosures, modular, prefabricated & all welded, RFI/EMI power line filters; signal line filters.
RF Shielded Anechoic Chambers

GENISCO TECHNOLOGY CORPORATION, 18435 Susana Rd., Rancho Dominguez, CA 90221
Telephone (213) 537-4750
EMI Filters and EMI Testing: FCC, VDE, MIL-STD-461, 200 V/m capability, 10 kHz-18 GHz, Mobile EMI test vans.

CHOMERICS, INC., 77 Dragon Ct., Woburn, MA 01888-4014
Telephone (617) 935-4850
EMI/EMP Shielding materials, gaskets, conductive compounds, shielded windows, vents and filters, cable shielding, FCC and TEMPEST Testing, application engineering, shielding tapes and laminates.

HONEYWELL, INC., Signal Analysis Center, P.O. Box 391, Annapolis, MD 21404
Telephone (301) 244-4500 Ext. 281
Complete services for EMI/EMC/TEMPEST, System Design and Integration.

SCHAFFNER EMC, INC., 825 Lehigh Ave., Union, NJ 07083
Telephone (201) 851-0644 Telex 685-3444
RFI/EMI Power Line Filters, EMC Testing, Instruments for Simulation or Measurement of EMI.

UNIVERSAL SHIELDING CORPORATION, 20 W. Jefryn Blvd., Deer Park, NY 11729
RF shielded enclosures, modular & prefabricated. RFI/EMI power and signal line filters, RF Waveguide Air Vents.

AMADOR CORPORATION, Wild Mountain Road, Almelund, MN 55002
Telephone (612) 583-3322 Telefax (612) 583-2242
Comprehensive EMI/FCC/VDE/MIL-STD-461 Testing, Consulting.

G & H TECHNOLOGY, INC., Electromagnetics Laboratory, 750 W. Ventura Blvd., Camarillo, CA 93010
Telephone (805) 484-0543
EMI Testing MIL-STD 461, TEMPEST, EMP Simulation, Design Engineering Consulting.

EATON CORPORATION, Electronic Instrumentation Division, 5340 Alla Road, Los Angeles, CA 90066
Telephone (213) 822-3061 TWX: 910-343-6969
EMI/EMS Measurement Instrumentation; Computer-controlled Systems for MIL/FCC/CISPR/VDE Requirements.

OMEGA PRECISION CORPORATION, 1384 Pompton Ave., Cedar Grove, NJ 07009
Telephone (201) 256-3422
EMI/EMP/ESD Shielding materials, Gaskets and Contact Strips both Standard and Custom Designed.

EMC SHIELDING, INC., 7341 Anaconda Ave., Garden Grove, CA 92641
Telephone (714) 891-8199 FAX (714) 895-8033
RFI/EMI Shielding materials: Honeycomb vents, shielded windows, EMI gaskets, conductive elastomers, knitted wire mesh, EMI/Dust filters.

WEINSCHEL ENGINEERING CO., INC., One Weinschel Lane, Gaithersburg, MD 20877
Telephone (301) 948-3434 (800) 638-2048
Precision RF and Microwave Components and Test Calibration Equipment.

SYRACUSE RESEARCH CORPORATION, Merrill Lane, Syracuse, NY 13210
Telephone (315) 425-5100 Dr. R. F. Wallenberg
Electromagnetics Research and Analysis; RCS Prediction Software; Shielded Room Design, Development, and Testing; Radar Imaging Techniques and Analysis.

An Institutional Listing recognizes contributions to support the publication of the IEEE Newsletter and TRANSACTIONS ON ELECTROMAGNETIC COMPATIBILITY. Minimum rates are $75.00 for listing in one issue; $200.00 for four consecutive issues. Larger contributions will be most welcome. No agency fee is granted for soliciting such contributions. Inquiries, or contributions made payable to the IEEE, plus instructions on how you wish your Institutional Listing to appear, should be sent to M. Bonaviso, The Institute of Electrical and Electronics Engineers, Inc., 345 East 47 Street, New York, NY 10017.