

# Electromagnetic Compatibility Society

Newsletter



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EDITOR: ROBERT D. GOLDBLUM

## SAE-AE4 COMMITTEE TO MEET

The SAE-AE4 Committee on Electromagnetic Compatibility will meet on Monday, August 17, 1981 prior to the IEEE EMCS Symposium, in Boulder, CO. The meeting will be held in the Harvest House Hilton at 9:00 A.M. in the Canyon Room.

## URSI TWENTIETH GENERAL ASSEMBLY WASHINGTON, DC

AUGUST 10-19, 1981

The International Union of Radio Science (URSI) meets for its General Assembly once every three years. The last General Assembly held in the United States was 24 years ago. A very extensive program (including more than 500 papers from all over the world) is planned for Washington, DC, August 10-19, 1981, presenting many original contributions in electromagnetics and electronics. For further details and registration material, please write to: Mr. R. Y. Dow, Organizing Committee for URSI XX G.A., National Academy of Sciences, 2101 Constitution Ave., N.W., Washington, DC 20418.

## DB SOCIETY ANNUAL BANQUET

The dB Society will conduct its annual banquet during the IEEE EMCS Symposium in Boulder, CO. The banquet will be held on Wednesday, August 19, 1981. Additional details may be obtained at the dB Society's Hospitality Suite.

## NEW DEVICE AIDS ARMY IN MEASURING ELECTROMAGNETIC RADIATION

NBS Researchers have developed an automated, highly portable system that Army personnel can use for determining electromagnetic radiation levels and for tracing interference problems. Consisting of five antennas, three commercial receivers and a microprocessor that controls the operation, the system has a frequency range from 10 kHz through 18 GHz. Using the new NBS system, the Army can realize a personnel saving of 3-to-1 and on-site measurement time can be reduced by a factor of 10. For more information, contact Fred McGehan at 303-497-3246.

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## EDUCATION COMMITTEE NEWS

Seminars and short courses on EMC related topics being offered in the fall and winter are listed below.

The Continuing Education Program at George Washington University is offering several courses in Washington, D.C. Hazardous Electromagnetic Radiation will be offered September 21-22. Lightning Protection is scheduled for September 28-29. Electromagnetic Interference and Control will be presented on October 12-16, and Grounding, Bonding and Shielding will be given on December 7-8. The instructor for these courses will be Dr. Bernhard Keiser. For more information on any of these courses, contact George Washington University at 202-676-6106 or 800-424-9773.

The Center for Professional Advancement is sponsoring two 4-day courses on Electromagnetic Compatibility Engineering. These courses will be offered on December 14-17 in San Francisco and on January 25-28, 1982 in Chicago. The instructors will be Henry W. Ott and Donald N. Heirman. For more information, contact the Center at 201-201-249-1400.

Don White Consultants will be offering Grounding and Shielding on September 15-17 in San Diego and on September 22-24 in San Francisco. FCC and VDE/CISPR Requirements, Testing and EMI Control is scheduled for Los Angeles on July 14-16. EMC Design of PCB's and Electronic Modules will be offered on September 22-24 in Los Angeles. MIL-STD-462/462B and System Level EMI Testing and Procedures will be presented in Boulder, CO on September 28 - October 2. For additional information on these courses, contact Don White International Training Center at 703-347-0030.

The National Bureau of Standards' Electromagnetic Fields Division will hold a three-day EMI measurement seminar at its Boulder, CO laboratories from August 25-27, 1981. Instruction will be by NBS' staff. Additional information may be obtained from M. Gerald Arthur, Room 4643 Radio Building, National Bureau of Standards, Boulder, CO 80303; Tel.: 303-497-3603.

R & B Enterprises will hold a series of one-day seminars on Product Safety, VDE/CISPR Requirements, and Design and Testing for Compliance to the new FCC, EMI Requirements. The seminars will be held in Chicago, September 15-18; Boston, September 22-25; Philadelphia, also September 22-25, 1981. Instruction will be by R & B Enterprises' personnel and consultants. Information is available from R & B Enterprises, P. O. Box 328, Plymouth Meeting, PA 19462; Tel.: 215-828-6236.

Henry Ott

Chairman  
EMCS Education Committee

## EMCS BOD ELECTION

The ballots for the election of six EMCS members for three-year terms on the Board of Directors will be in the mail on or about August 1, 1981. All members are encouraged to vote and to return their ballots before the deadline of September 11, 1981.

### NEWSLETTER STAFF

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## EMCS SYMPOSIA

The next IEEE EMC Symposium will be held in Boulder, CO on August 18-20, 1981. See the inside back cover of this Newsletter for exact location and other information.

The following is a schedule for future symposia:

- 1982 - San Francisco, Sept. 7-10
- 1983 - Washington, DC, Oct. 18-20
- 1984 - Tokyo (No date yet)  
and  
San Antonio, TX, Apr. 24-26
- 1985 - Wakefield, MA, Aug. 20-22
- 1986 - San Diego, Oct. 8-11

## PRESIDENT'S NEW SCIENCE ADVISOR MEETS WITH ENGINEERING GROUP

Dr. George A. Keyworth, Presidential Science Advisor, recently met with a delegation from the IEEE. He stated that he welcomes "advice from the engineering community" in fulfilling part of his new position as Director of the Office of Science and Technology Policy (OTP). Dr. Keyworth said that he expects to draw on advice and consultation from engineers and scientists who are close to the issues.

The IEEE delegation was led by Dr. Richard J. Gowen, Vice President of Professional Activities and Chairman of the United States Activities Board (USAB), and Dr. Russell C. Drew, Vice Chairman of USAB and Chairman of its Government Activities Council. Accompanying the group was Dr. Bruno O. Weinschel, Chairman of the Engineering Affairs Council of the American Association of Engineering Societies. Views were exchanged on industrial innovation, national productivity, Federal support of research and development, and engineering education - all issues of major concern to engineers and under the administration's new policies.

The collection of IEEE position papers on technological policy issues was presented by Dr. Gowen. The recent Institute position on tax incentives to promote industrial research and development and new product innovation was discussed in the context of a number of Congressional and Administration-initiated tax-cutting proposals.

## FCC ACTIVITIES

The FCC Office of Science & Technology has released Bulletin OST 52: "Interpretations of the FCC Rules for Computing Devices." Copies can be obtained from the FCC Consumer Assistance Office (202-632-7000), FCC, 1919 M St., N.W., Washington, DC 20554.

Originally, copies of the computer test procedures adopted under Docket 80-284 were to have been distributed by National Technical Information Service. There was a last minute change in procedure; this was published as Appendix A to Part 15 of FCC Rules. Part 15 is included in Volume II of FCC Rules, which may be purchased from Superintendent of Documents, U. S. Govt. Printing Office, Washington, DC 20402. This volume has just been reprinted, with all changes to about May 1st. Price is listed as \$12.50 postpaid, which will include supplements covering future changes as released.

The Computer and Business Equipment Manufacturers Association (CBEMA) has filed a petition for limited reconsideration of the Report and Order released March 23, 1981 under Docket 80-284. While CBEMA recognized the significant achievement of the standard test procedures adopted in that proceeding, they raised objections to certain of the provisions. These were:

1. Recommendations of Paragraphs 4.2.5 and 6.1 for preliminary testing before installation on test site, to establish the "worst case emanation potential of the EUT."
2. The requirement of those paragraphs for testing with two sets of interconnecting cables (shortest and longest expected to be used with EUT), and to bundling of excess cable length at mid-cable on test stand.
3. Heights specified for table-top devices during measurement of both radiation and power line conducted emissions.
4. Provisions for measurement of radiation at distances less than 10 meters.
5. Publication of LISN impedance parameters below 450 kHz, in which portion of the frequency range CBEMA contended that the curve published in the NPRM is not accurate.

This petition may be inspected at the Commission's Washington office. Anyone desiring to obtain a copy should communicate with the Commission's duplicating contractor:

Downtown Copy Center  
1114 - 21st St., N.W.  
Washington, DC 20037  
Tel.: 202-452-1422

There is a charge for such copies.



## UPDATE ON SOCIETY PROGRESS



Donald N. Heirman  
President

Our Society progress and activity since the last Newsletter has been at a reasonable pace and several items of interest to our members are worth mentioning.

1. The Littleton (Denver) Chapter of the EMC Society is a reality, as of June 8, 1981. The interim Chairman is the organizer, Abul Rashid, 6301 W. Hampden, Apt. 9-201, Denver, CO 80227. We welcome the new chapter and note that this is the first time we have two chapters from the same Society in the same IEEE Section. Hope that the paperwork doesn't get in the way. We all wish the new chapter success.
2. Plans for the EMC Chapter in Ottawa, Canada, and the one in San Antonio, TX, also are moving ahead. Spearheading the San Antonio Chapter birth is Kurt Fischer from Southwest Research Institute who is preparing the necessary petition. The Ottawa plans are still formative. Until plans firm up, those Canadian Society members in the Ottawa area who are interested in getting their own chapter should contact Stan Xavier, Bell Northern Research, P. O. Box 3511, Station C, Ottawa K1Y 4H7.
3. Our Standards activity is continuing. The IEEE Standards Board on May 21st approved our revised standard 475 on "Measurement Procedures for Field Disturbance Sensors. This work was done by Ralph Taylor. We urgently need help on the other standards we are responsible for. Last December, Bud Taggart, our Standards Chairman, sent out an urgent plea to the chapter chairmen for local help. He did not receive a single response. I am personally sending the same request to each chapter chairman reiterating the same plea. We have standards which are 20 years old that must be updated. Please, help this time.

4. Gene Knowles, Chairman of the Nominations Committee, reports that the petitions for Board of Directors have been received ahead of schedule and that the ballots for election will be out by August 1st or sooner. Election results will be announced in the Fall Newsletter. Since elections will be after the EMC Symposium, installation of the newly elected members-at-large and the Society officers will take place at the last yearly Board meeting which initially is scheduled for Tuesday, 10 November 1981 at MIDCON in Chicago.
5. At the 4-5 June IEEE Technical Activities Board (TAB) meeting, your President attended and reports some of the activities:
  - a. An IEEE position paper on "Human Exposure to Microwaves and Radio Frequency EM Fields" was presented. Some of the information seemed controversial and, hence, it was tabled until the next meeting on 21 August. If interested in the statement, contact our COMAR representative, Joe Chislow on 201-949-6600 and he'll answer your questions.
  - b. Fees for the 34,000 student members of IEEE were increased to \$5.00.
  - c. A technical achievement award sponsored by TAB was established. This will allow EMC Society as well as other smaller Societies to get an IEEE award since heretofore the major field awards in areas which the EMC and other highly specialized Societies did not work.
  - d. A revised pre-college guidance booklet was distributed for comment. The booklet introduces the high schooler to careers in electrical, electronics, and computer engineering fields.
  - e. An IEEE energy briefing package draft is being pulled together for use at meetings open to the general public. It presents a balanced view of all sources of energy, based on authoritative data. It is a slide show with script and a list of answers to most asked questions. Contact H. U. Brown at IBM, 1133 West Chester Ave., White Plains, NY 10604 for details.
6. Our EMC Symposium is 18-20 August 1981. The day before at 1-5 P.M., the Board of Directors meets at the Hilton Harvest House. The meeting is open to all Society members. In addition, there will be a Chapter Chairman Breakfast on Wednesday, 19 August, and a Society Information Booth in the Exhibit area staffed by Board members during the noontime and break periods throughout the Symposium. More about these activities will be posted at the Symposium. There are over 100 papers which will be presented. Many of these surely will affect your jobs. If you haven't received a program, contact Charlotte Tyson at 303-447-5072. Let's have a big turnout.



# EMC STANDARDS ACTIVITIES



by Richard B. Schulz

## STATUS REPORT ON NEW/REVISED EMC STANDARDS

The following new standards or related publications now are available:

**ANSI - C63.4-1980.** Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 10 kHz to 1 GHz; Mar. 31, 1981. 22 pp. \$7.00. SH 08219. (Order from IEEE.)

**IEEE - 377-1980.** IEEE Recommended Practice for Measurement of Spurious Emission from Land-Mobile Communication Transmitters; Nov. 14, 1980. 26 pp. \$6.00. SH07898. (Order from IEEE.)

**DOD - MIL-HDBK-335.** Management and Design Guidance Electromagnetic Radiation Hardness for Air Launched Ordnance Systems; 15 Jan 1981. (Request from Naval Publications and Forms Center, 5801 Tabor Ave., Phila., PA 19120.)

## SCHEDULED MEETINGS OF EMC STANDARDS COMMITTEES

Scheduled meetings of voluntary committees that develop and coordinate EMC standards follow.

COMMITTEE	NAME	NEXT MTG.
ANSI C63	Radio Elec. Coord. Techn. & Develop.	8/21/81 Hilton Harvest House Boulder (EMC '81)
ANSI C68	High-Voltage Testing Techniques	Unscheduled
ANSI C95	Radio Frequency Radiation Hazards	Unscheduled (Fall)
ANSI MD 105	Medical Electronics	Unavailable
CBEMA ESC5	Environment & Safety Comm. - Subcommittee 5	8/17-18/81 Hilton Harvest House Boulder (EMC '81)
EIA G-46	Electromagnetic Compatibility	8/21/81 Hilton Harvest House Boulder (EMC '81)

EIA R-2	Consumer Electro-magnetic Compatibility	Unscheduled
EIA TR8.10	Vehicular Electrical Interference & Electromagnetic Compatibility	Unscheduled
IEEE S27	EMC Standards Committee	8/17/81 Hilton Harvest House Boulder (EMC '81)
SAE AE-4	Electromagnetic Compatibility	8/17-21/81 Hilton Harvest House Boulder (EMC '81)
SAE ESC/SC	Electronic Systems Comm./EMI Standards & Test Methods Subcommittee	8/17/81 Hilton Harvest House Boulder (EMC '81)
SAMA PMC 33	Process Measurement & Control	8/14-15/81 Place - TBD

## 1981 SALARY AND FRINGE BENEFIT SURVEY AVAILABLE

The IEEE 1981 U. S. Membership Salary and Fringe Benefit Survey recently has been published by the IEEE. Survey results are based on a questionnaire mailed in early January 1981 to a scientific sampling of IEEE Members, Senior Members, and Fellows in the U. S. The Survey reports on EE salaries as they relate to numerous variables, such as job function, supervisory responsibility, type of employer, company size and geographic location, years of experience and level of education.

The Survey also contains extensive tables showing income based on numerous pairs of variables simultaneously, such as income vs. geographic region by industry or service of employer, and income vs. years with present employer by organization job function. Additional sections will include survey statistics on pensions and supplementary retirement plans, life, health, accident and major medical insurance coverage, employer contributions to professional society activities and vacations.

The IEEE U.S. Membership Salary and Fringe Benefit Survey (UH01453) may be ordered from the IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854, priced at \$45.00 for members and \$60.00 for non-members.





G. Robert Redinbo

Dr. Henning Harmuth is visiting the People's Republic of China this summer and he has sent me the following letter which I am to share with the readers of this newsletter.

## LETTER FROM CHINA

H. F. Harmuth

The rousing tunes of the march "Red Flag" come over the loudspeaker system at 5:40. The more active - meaning the freshman students - get up to be ready for the morning exercise that is directed via the loudspeakers a few minutes later. The less active, including my wife and me, turn over one last time. Another day is getting started at the Northwest Telecommunication Engineering Institute in Xi'an, People's Republic of China.

At 7:00 we are in the dining room and steer carefully our way past octopi, centipeds, pickled eggs and other goodies to the cold bun and the hot milk. Fortunately, there are always plenty of warm roasted peanuts, although it takes practice to catch one with chopsticks and transfer it successfully into one's mouth.

My wife is off to her English class by 7:30. An interpreter drops in to look at the viewgraphs at 8:00. One lecture series is on "Nonsinusoidal Waves for Radar and Radio Communication," a second one on "Acoustic Imaging with Electronic Circuits." There are about 70 attendees. They are all post-graduates. Half are from the Northwest Telecommunication Engineering Institute, the others have been assembled from all over China. The expense must be enormous, but China spares no expense to advance education and industrialization. Another Japan is clearly in the making.

For an example of what China is willing to do for education, let us look at the library of the Northwest Telecommunication Engineering Institute. It is as specialized as the name of the institute itself. There are about 600 journals on communications and related fields. Every last journal of IEEE, Bell, RCA, IBM, etc. is there. There are some 60 German language journals, including the rarely seen journals published by companies such as Siemens and Brown Boveri. Japanese journals are galore. How do they par for all this? A low-cost way has been found.

Almost all journals have been reprinted in China, so that only one copy each had to be imported. The only exceptions I saw were Microwave Journal and Defense Electronics, and they come free of charge. Is there any university in the U.S. with a comparably comprehensive coverage of scientific journals?

To see the scope of the industrialization effort, let us look at the test equipment and the components available at the Northwest Telecommunication Engineering Institute. There are plenty of the standard instruments, such as oscilloscopes (up to 30 MHz bandwidth). An oscilloscope with 100 MHz bandwidth is said to be produced; but, I have not seen one. Also, signal generator, pulse generators, multimeters, power supplies, etc. are plentiful. Every one is made in China. They lack the sophistication and finish of U.S. instruments, but how many countries are there that can produce a sufficient line of test instruments? A small Chinese made computer is there with 10 Chinese made teletypewriters as terminals and one high-speed printer. The performance is not up to U.S. standards, but the same held true for Japanese products a generation ago. Small scale integrated circuits are available, including an operational amplifier similar to the 741. There are many problems of reliability and performance, but there is a prototype 12-channel digital telephone signal multiplexer based on Paley functions. (Paley functions are for the number 12 what Walsh functions are for powers of 2) in Xi'an, and a 16-channel telemetry multiplexer based on Walsh functions at the Beijing (Peking) Institute of Aeronautics and Astronautics. No such development succeeded in the U.S. against the well established interests of frequency and time multiplexing, just as the introduction of small cars with front wheel drive did not succeed ten years ago.

As one would expect, the heavy emphasis on education and industrialization keeps the living standard at a minimum. There is little point in stating that a typical salary works out to be about \$1.50 per day, since housing, medical care, education and many other things are either completely or almost free. The bare necessities are provided for everybody, but anything beyond is invested.

By 10:30 P.M., we are all ready to call it a day. The loudspeaker system, having worked on and off for almost 17 hours, sounds tired too, but in a final effort it belts out a few tunes from - I understand - the "Red Pillowcase" slumber song. A long day is coming to an end at the Northwest Telecommunication Engineering Institute.



# EMC PERSONALITY PROFILES

by William G. Duff



HAROLD E. TAGGART

"BUD"

Bud Taggart has been with the National Bureau of Standards (NBS) in Boulder, CO since 1956. When he joined the NBS, he was assigned to the Standards Division where he had the responsibility of developing and maintaining the National Antenna Standards and calibrating antennas and field strength meters submitted to NBS. This gave him an early introduction to EMC type measurements and the many problems associated with performing accurate interference measurements.

He is presently project leader of a group that has the responsibility of establishing reference fields that can be used to analyze the performance of antennas, determine the characteristics of open field sites, determine the susceptibility of equipment to electromagnetic fields or characterize the electromagnetic environment. This work includes measurement techniques involving TEM cells, open-field measurements, anechoic rooms, shielded rooms and near field measurements. His expertise in electromagnetic measurements and his experience in developing electromagnetic standards gives him a background that is unique to few EMC engineers. His principal fields of technical competence include the areas of antennas, field strength standards, electromagnetic interference, telecommunications, and electromagnetic standards.

Over the years, Bud has been involved in many different types of projects for DoD, the FAA, the FCC, and other government agencies. As an example, he was the principal investigator when assisting the FAA in developing standards for mandatory use of emergency locator transmitters (ELTs) for downed aircraft. A technical report was prepared which became part of the FAA regulations regarding the performance of ELTs. For several years, he was responsible for managing a communications program sponsored by the DoD which involved the many types of electronic and radio equipment used in public safety communication systems. This program prepared over 30 technical papers and performance standards related to communication equipment such as antennas, transmitters, receivers, repeaters, scramblers, and surveillance systems.

Bud has published many technical papers related to his field of work and is very active in the EMC standards community.

- He is a senior member of IEEE.
- He is a fellow member of the Radio Club of America.
- He is Chairman of the IEEE EMC Society Standards Committee.
- He is Chairman of the 1981 EMC Symposium to be held in Boulder, CO in August 1981.
- He is an associate editor of the IEEE Transactions on Electromagnetic Compatibility.
- He is a member of the SAE AE-4 Committee.
- He is a member of ANSI C-63 Committee.
- He is a member of URSI, Commission E.
- He is past Chairman of the Denver IEEE EMC Chapter.
- He is past member of the IEEE EMC AdCom.
- He has presented numerous papers at various seminars and to IEEE technical meetings.

Prior to joining NBS, he was an electronics instructor for the U. S. Air Force. He is also a veteran of the U. S. Navy. He was educated at the University of Denver, receiving his B. S. Degree in 1950 and continued his studies at the University of Colorado.

In his spare time, Bud enjoys the outdoors. He particularly enjoys big game hunting and fishing in the high country of the Rocky Mountains. He also has a cattle ranch nearby which keeps him busy every weekend either fixing fences, rounding up cattle, or doctoring cattle.



# Book Reviews



by Jim Hill, EMXX Corporation

The book reviewed in this issue is by Prof. Kamilo Feher of the University of Ottawa, author of a number of papers and books in the fields of microwave, cable and satellite transmission methods. We recently reviewed his book, "Digital Modulation, Coding and Signal-Processing techniques," published by Don White Consultants, Inc.

The comprehensive review of "Digital Communications: Microwave Applications" was submitted by Dick Schulz of IITRI, Editor of the Transactions on EMC.

*"Digital Communications: Microwave Applications"*

BY

Kamilo Feher

Published by Prentice Hall, Inc.  
Englewood Cliffs, NJ, 07632, January 1981  
Price, clothbound, \$28

Reviewed by Richard B. Schulz  
IIT Research Institute  
Annapolis, MD

According to the preface, this book is intended both for engineers and for managers associated in some respect with microwave communications systems or equipment. It should serve its intended purpose quite well, and even more. Any EMC engineer concerned with the interaction of such communication systems or equipment with the electromagnetic environment will find much material pertinent to his effort.

The value of this book lies in the excellent selection of technical material (including many figures, as well as tables and equations), which is well organized and explained with unusual clarity. Such clarity is enhanced for the reader by the use of well selected problems distributed throughout to illustrate specific points. All are intended to be worked by the reader, some without, and some with, printed solutions. The book is well balanced for subject content and exhibits uniform style, even for two of the twelve chapters not written by the author, but by other experts in those areas. An excellent glossary is included, as well as references at the end of each chapter and a detailed subject index.

A first chapter titled the "Transmission System Environment" covers trends among different types of systems, digital telephony and the several principal hierarchies in use around the world, and basic system configurations. The second chapter on "Statistical Methods in Digital Transmission System Analysis" is intended primarily for those without a background in statistics, but also serves as a good refresher for others. These, in effect, constitute the introductory portion of the text.

The main subject matter of the book begins with Chapter 3, "Digital Modulation Methods." Here, the performance of pulse-amplitude-modulated (PAM) baseband and coherent phase-shift-keyed (PSK) systems in additive white Gaussian-noise (AWGN) is considered in depth, assuming no non-linearity (as from a traveling-wave-tube (TWT) amplifier). Other techniques covered include amplitude-phase-shift (APK) keying, digital vestigial-sideband suppressed carrier (VSB-SC), quadrature digital AM (QAM) and pulse-amplitude-modulated (PAM) FM. Performance of these systems in an AWGN environment is given in terms of the probability of error  $P(e)$ .

Chapter 4 on Microwave Amplifiers is written by Dr. Wolfgang J. R. Hoefer. The importance of this chapter lies in the large contribution of such amplifiers to  $P(e)$ . Accordingly, the most common types are discussed, as well as the requirements imposed upon them. Two basic categories include power amplifiers and small-signal amplifiers.

The subject of Chapter 5 is "System Gain: The Concept and Its Applications." Reliability objectives are discussed and system gain requirements to most of the objectives are defined and displayed graphically. Among the factors which contribute to gain requirements are multipath fading and co-channel interference. Both theoretical and experimental data are presented.

With Chapters 3-5 as a basis, Chapter 6 deals with M-ary PSK and QAM Microwave Systems. M-ary phase-shift-keyed (PSK) and M-ary quadrature-amplitude-modulated (QAM) digital radio systems frequently have a spectral efficiency better than 3 bits/second/hertz (compared to the Nyquist theoretical maximum of 2b/s/Hz for a binary signal). Spectrum-efficient systems are discussed, as well as filtering requirements and performance design guidelines. Existing commercial systems are compared.



Chapter 7 is titled "Correlative (Partial Response) Techniques and Applications to Digital Radio Systems," written by Dr. Adam Lender. This chapter is an in-depth treatment of many aspects of the correlative (or partial-response) techniques applicable to digital microwave systems, including binary and duobinary (double the speed of binary). Nyquist criteria are based on the premise that each digit is confined to its own time slot and, hence, (theoretically) independent of other digits. By contrast, correlative techniques introduce, deliberately, a limited amount of inter-symbol interference and capitalize on it, and result in reshaping pulse trains. Consequences are: (1) Ability to transmit more bits per second in a given bandwidth for a given probability of error; (2) Rates substantially higher than Nyquist rates are possible; (3) Distinctive pulse-train patterns simplify error-detection; principles and practical applications are presented.

A collection of subjects is treated in Chapter 8, Digital and Hybrid Potpourri. In addition to systems already discussed, a number of analog FDM-FM microwave systems have been "converted" to carry a mixture of analog FDM and digital TDM traffic. Hybrid systems discussed include data under voice (DUV), data in voice (DIV), data above voice (DAV), and data above video (DAVID), as well as a single-channel-per-carrier (SCPC) satellite system for sparsely populated rural areas.

These include a wide range of bit rates (64 kb/s to 400 Mb/s).

Chapter 9 on Digital Microwave Systems Design is concerned primarily with the impact of FCC Regulations and CCIR Recommendations on digital-radio-system design.

Following the previous material on unprotected single-channel radio systems comes Chapter 10 on Diversity and Protection Switching Techniques, primarily to protect against failures due to equipment malfunction and multipath fading. Space- and frequency-diversity systems are discussed, as well as switching and combining techniques.

Chapter 11 on Measurement Techniques covers both laboratory and in-service type measurements. Ingenious techniques are disclosed for (1) on-line pseudo-error measurement and (2) on-line jitter measurement.

The book concludes with Chapter 12 on Research and Development Trends and Unsolved Problems. The most valuable contribution of this chapter is to highlight those publications to be watched for new information on microwave digital communications.

In summary, this is an excellent book for its intended readership and should prove quite useful to EMC engineers concerned with microwave digital communication systems.

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## EMCABS



EDWIN (ED) BRONAUGH

In this issue we are publishing 42 abstracts. These are abstracts on various EMC topics. We plan to continue publishing abstracts of papers from previous EMC Symposia and from other conferences. The present EMCABS committee is composed of the members listed below. We now have several volunteers which will be abstracting EMC articles. Their names will be listed in future issues.

L. F. Babcock	E. L. Bronaugh
D. R. Kerns	R. N. Hokkanen
R. B. Schulz	R. M. Showers



The Fourth Electromagnetic Compatibility Symposium and Technical Exhibition was held at the Federal Institute of Technology Zurich (ETHZ), Switzerland from March 10-12, 1981. With an attendance of 529 participants from 25 countries and 25 exhibitors, it has been the largest of all preceding conferences (see Table) and may at present be regarded as the most significant international event in the field of EMC.

The symposium was sponsored by the Association of Swiss Electrotechnicians (SEV/ASE) and organized by the Institute for Communication Technology of the ETHZ under the auspices of Mr. F. Locher, Director-General of the Swiss PTT. President of the conference was Prof. Dr. P. Leuthold, Organizing Chairman, Dr. T. Dvorak, and the Program Committee was chaired by Prof. Dr. F. L. Stumpers. Workshop organizer was Mr. H. K. Mertel. A number of international and national organizations cooperated technically.

Meeting place, year	Mon-treux 1975	Mon-treux 1977	Rotterdam 1979	Zurich 1981
No. of participants	396	444	507	529
No., countries	26	25	24	25
No., papers in Record	108	106	107	102
No., exhibitors	18	19	23	25

At the opening session, Prof. M. Cosandey, President of the Council of Swiss Federal Institutes of Technology discussed the technical and administrative aspects of research in modern society and Mr. Locher reviewed the development and future tasks of the EMC discipline. The announced talk of Mr. J. L. Moe on behalf of the SAE AE-4 Committee on EMC was not given due to the absence of the speaker.

The 97 papers offered at the Symposium were delivered in 18 sessions: "Spread Spectrum Compatibility," "Characterization of Interference and Noise and Evaluation of System Performance" (Special URSI Session), "Intra-system EMC," "Mathematical and Computer Methods in Spectrum Utilization," "Nuclear EMP I & II," "EMI in Microelectronics," "Biological Effects," "Coupling," "Immunity," "EMC in Communications," "Particular EMI Sources," "Measurement Options for the Future," "Reliability, Limits, Measurements," "Available Computer Programs for the EMC Engineer," "Shielding and Grounding," "Lightning and Power Lines," "EMC Analysis and Modeling."

Three workshops were organized: "EMC Diagnostics" (offered by SAE AE-4 Committee on EMC), "EMP Hardening of Electronic Systems" (offered by Dr. F. M. Tesche) and "Applications of Programmable Calculators and Computers for EMI Prediction and EMC Design" (offered by D. J. White).

Post-Symposium technical excursions included a tour of the Federal Institute of Technology at Zurich-Centre and visits to the laboratories of Brown, Boveri & Cie., AG at Haden and of Siemens-Albis at Zurich.

On the first day of the Symposium, a get-together cocktail party was organized, followed on the second day by a banquet given in the festive atmosphere of an old Zurich guild house. On the last day of the conference, all authors and Symposium officers were guests of the Symposium at an Authors Lunch. The usual ladies program featured several excursions, including a visit to Luzern.

The Program Committee of the Symposium awarded the following papers: C. R. Paul, "Adequacy of Low-Frequency Crosstalk Prediction Models"; F. M. Tesche, T. K. Liu, "Recent Developments in Electromagnetic Field Coupling to Transmission Lines"; R. Bersier, "Measurement of the Immunity of TV Receivers to AM, RF-Fields in the 3 to 30 MHz Range, Including the Influence of Connected Cables"; M. L. Crawford, "Options to Open-Field and Shielded Enclosure Electromagnetic Compatibility Measurements"; M. Borsero, E. Nano, "Comparison Between Calculated and Measured Attenuation of the Site Recommended by IEC for Radiation Measurements"; and, B. Demoulin, P. Degauque, M. Cauterman, "Shielding Effectiveness of Braids with High Optical Coverage." The first three papers also received monetary prizes. All papers presented at the Symposium have been included in the 563 page Proceedings, "Electromagnetic Compatibility 1981," available at 100 Swiss Francs (including postage and handling costs) from: Dr. T. Dvorak, ETH Zentrum-IKT, 8092 Zurich, Switzerland.

The next EMC Symposium will be held again at Zurich and is scheduled for March 8-10, 1983. A Call for Papers will be issued by the end of 1981, abstracts will be due by March 1982.



## STANDARDS, INSTRUMENTS, AND TECHNIQUES NEEDED FOR MEASURING NONIONIZING RADIATION

The need to develop and to improve instrumentation, measurement standards, calibration services and standardized measurement techniques for nonionizing radiation far outweighs the need to establish regional calibration laboratories at this time. That is the conclusion of a group of radiation measurement and control experts as reported in a study submitted recently to the Senate Committee on Commerce, Science and Transportation by the Commerce Department's National Bureau of Standards (NBS).

Prepared at the Committee's request, the report provides a detailed assessment of the existing measurement capabilities, applications, limitations, and requirements of the national measurement system for nonionizing electromagnetic radiation. Some 84 specific measurement-related needs were identified with slightly more than half considered to be of high priority. About 80 percent of these high priority tasks are being addressed by NBS and other organizations, the report says. The group listed the capability to make simultaneous measurements of both the electric and magnetic fields from a nearby source as the most important measurement problem to be solved at this time. This problem is among the high priority tasks being addressed by NBS. In transmitting the report to the Committee, NBS Director Ernest Ambler states, "The findings of this study should provide a base upon which national plans can be formulated."

The 40-page report was prepared by NBS in cooperation with the Conference of Radiation Control Program Directors, an organization of radiation control officers at the state and local levels. The Senate committee had recommended that the two organizations review the need for an intermediate level of regional calibration labs to improve the ties between NBS and those making measurements in the field.

For purposes of this report, nonionizing radiation is defined as that portion of the electromagnetic spectrum extending from 0 hertz (cycles per second) to 300 GHz ( $3 \times 10^{11}$  cycles per second). This portion of the spectrum includes both static (D.C.) and slowly varying electric and magnetic fields (e.g., those from high-voltage power transmission lines), as well as microwave and other radio frequencies. Common sources include commercial and private broadcast stations, radar, and navigational aids, as well as microwave ovens and medical diathermy equipment.

## 1981 IEEE ANNUAL CONFERENCE ON NUCLEAR AND SPACE RADIATION EFFECTS

The 1981 IEEE Annual Conference on Nuclear and Space Radiation Effects, sponsored by the IEEE/NPSS Radiation Effects Committee in cooperation with the University of Washington and Cosponsored by the Defense Nuclear Agency/DoD, Jet Propulsion Laboratory/NASA and Sandia National Laboratories/DoE, will be held at The University of Washington, Seattle, Washington, July 21-24, 1981.

Topics of the Technical Sessions will be:

- Radiation Effects on Devices, Circuits and Systems
- Basic Mechanisms in Materials and Devices
- VLSI
- EMP/SREMP
- SGEMP/IEMP
- Fabrication of Hardened Components, Testing, and Hardness Assurance
- Radiation Simulation, Energy Deposition, and Dosimetry
- Spacecraft Charging and Space Radiation Effects
- Single Particle Upset Phenomena

For additional information, contact Howard H. Sander, Sandia National Laboratories, Division 2143, P. O. Box 5800, Albuquerque, NM 87185; Tel.: 505-844-1209.

## TAX INFORMATION FOR IEEE OVERSEAS CONFERENCE ATTENDEES

The U.S. Internal Revenue Service recently rewrote regulations regarding tax deductions for U.S. residents travel to overseas conventions. Here's what you ought to know: Non-reimbursed expenses will be deductible if the taxpayer can prove that the conference or meeting is directly related to the active conduct of his/her trade or business and that it is reasonable for the conference to take place outside North America. Basically, this means that IEEE members properly attending overseas meetings no longer will be subject to the "two foreign conventions per year" limitation.



## EDITORIAL

Numbers can be manipulated in many ways when one wishes to use them to his advantage. In the June 1981 issue of The Institute, the IEEE published a statement on its 1980 financial operations. The General Funds Summary shows that 15% of its income came from advertising revenue, primarily from The Spectrum. Membership dues provided 33.1% of the income. Under expenses, The Spectrum and The Institute represented 24.8%. One could conclude, therefore, that most of your dues was used to support the publications (74.9%), ignoring the IEEE's deficit of \$471,000.

The numbers game continues where they show that \$4.75 (15.8%) of the \$35/year membership dues goes toward publishing. It is assumed that remaining support of the publications is allocated from investments and other incomes.

Let's consider, for the moment, that the IEEE ceased publishing The Spectrum. This would eliminate most of the 24.8% of the IEEE's expenses, whereas it would cut only about 15% of its income. The result would be an apparent gain of 9% to the IEEE. Also, the \$4.75 from your dues (or 74.9% of your dues, whichever you choose to believe) could be spent on other IEEE services, or used to reduce the dues.

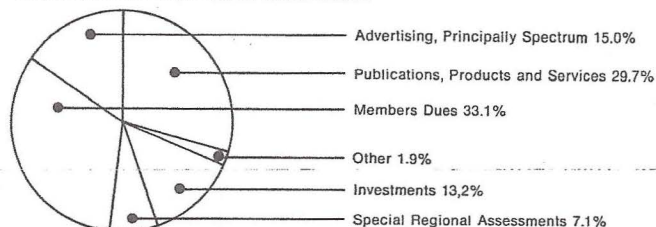
Depending upon how you wish to manipulate the numbers, you are paying from \$4.75 to \$26.22 per year for The Spectrum. This presents obvious questions: What is The Spectrum worth to you? How much are you willing to pay for it? Would you rather that your money be put to other uses, such as an increase in other services or reduction of dues?

The General Funds 1980 Summary is included for your review, in case you missed it in the June 1981 Institute. Please drop me a line with your opinion so that we can give the IEEE a consensus from the EMCS.

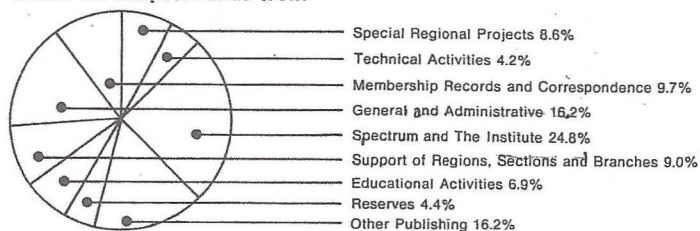
Editor

### GENERAL FUNDS 1980 SUMMARY

Where the General Funds Came From

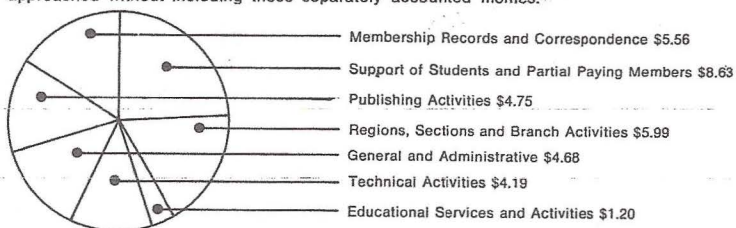


Where the General Funds Went



Where the \$35.00 Dues Went—1980

Where your dues dollars went—the \$35 pie. U.S. and Canadian members, in particular, should be aware, that the graphs do not include their special dues assessments on the principle that those assessments were approved by those Regions' members for special projects of a supplementary nature, and any historical evaluation of IEEE's efficiency can be better approached without including those separately accounted monies.



## NBS TO HOLD EMI MEASUREMENT SEMINAR

The National Bureau of Standards will hold a three-day technical seminar on the measurement of electromagnetic interference (EMI) at its Boulder, Colorado laboratories from August 25 to 27, 1981. The seminar, which will combine lectures and laboratory demonstrations, is open to engineers, scientists, technicians, and managers from industry, government and academia. The purpose of the seminar is to provide these groups with the most up-to-date information on instruments, techniques and the related theoretical basis for measuring electromagnetic interference.

NBS experts, who have pioneered in the development of EMI measurement techniques, will conduct the seminar. Topics to be covered will include transverse electromagnetic (TEM) cells, open-field testing, anechoic chambers, electromagnetic field probes, remote sensing and scanning units, and environmental measurement techniques.

To provide maximum interaction for participants, attendance at the seminar will be limited to 40 persons on a first-come, first-served basis. The cost is \$595.

The NBS seminar will follow the Institute of Electrical and Electronic Engineers 1981 International Symposium on Electromagnetic Compatibility, which will be held at the University of Colorado in Boulder from August 18th to 20th. To preregister, or to obtain more information about the NBS seminar, contact M. Gerald Arthur, Electromagnetic Fields Division, National Bureau of Standards, Boulder, CO 80303; Tel.: 303-497-3603.



Analysis of Nonlinearly Loaded Multiport Antenna Structures Over an Imperfect Ground Plane Using the Volterra-Series Method  
T.K. Sarkar, D.D. Weiner, and R.F. Harrington  
Sarkar-Rochester Inst. of Tech. on leave at Harvard U.  
Weiner and Harrington-Syracuse U.

ACCESSION NO.  
EMCABS 6-81-1

IEEE Trans. EMC, Vol. EMC-20, No. 2, pp 278-287, May 1978

**ABSTRACT:** Volterra-series analysis is applied to nonlinearly loaded antennas over an imperfect ground plane. The nature of the imperfect ground can be taken into account either exactly by the Sommerfeld formulation or approximately by the reflection-coefficient method. After the electromagnetic-field problem is reduced to a network problem by application of the method of moments, the distributed nonlinear loads are approximated by lumped loads. The nonlinear network problem is then solved using the Volterra technique. A procedure for obtaining a time-domain solution from the frequency-domain solution without using the fast Fourier transform technique is demonstrated.

**INDEX TERMS:** Multiport antennas, nonlinearly loaded, imperfect ground, Volterra-series method.

Reference Potential Terms in Static Capacitance Calculations via the Method of Moments  
Clayton R. Paul

ACCESSION NO.  
EMCABS 6-81-2

University of Kentucky

IEEE Trans. EMC, Vol. EMC-20, No. 1, pp 267-269, Feb 1978

**ABSTRACT:** In an earlier publication (1), a numerical method for determining the per-unit-length generalized capacitance matrix for a system of parallel cylindrical dielectric insulations (wires) was given. In the formulation of the method, potential expressions were developed in which reference-potential terms were omitted. In this paper, a proof of the validity of omitting the reference-potential terms is presented.

**INDEX TERMS:** Capacitance matrix, reference-potential terms, valid omission, proof.

Near Fields of Thin-Wire Antennas - Computation and Experiment

A. T. Adams, T. E. Baldwin, Jr., and D. E. Warren  
Adams-Syracuse Univ.; Baldwin-Atlantic Research Co.;  
Warren-Rome Air Development Center

ACCESSION NO.  
EMCABS 6-81-3

IEEE Trans. EMC, Vol. EMC-20, No. 1, pp 259-266, Feb 1978

**ABSTRACT:** Techniques for the computation of near fields of thin-wire antennas have been reported in the past. In this paper, the methods for such computation are reviewed, some recent developments are described, and extensive experimental verification is reported. The computed near fields of resonant dipole are compared with experiment. The near fields of broadside and endfire linear arrays are reported. The broadside near-field patterns narrow, whereas the endfire patterns broaden, as distance from the array center increases. Finally, the relevance of near-field computation to near-field radiation hazards and to near-field measurements is discussed.

**INDEX TERMS:** Thin-wire antennas, near fields, computation, experiment, radiation hazards, measurements.

On The Electromagnetic Fields From a Hybrid Type of EMP Simulator

Ronald F. Blackburn and Clayborne D. Taylor  
Blackburn - Air Force Weapons Laboratory; Taylor- Mississippi State University

ACCESSION NO.  
EMCABS 6-81-4

IEEE Trans. EMC, Vol. EMC-20, No. 1., pp 240-247, Feb 1978

**ABSTRACT:** A typical hybrid type of EMP simulator that is used in the simulation of the nuclear electromagnetic pulse is analyzed. Because of the width of the pulse frequency spectrum, the behavior of the antenna is determined separately for three specific frequency regimes. Also, the pulse-power source interaction with the antenna is considered. After the frequency response of the antenna is determined, Laplace transform theory is utilized to obtain the pulse response. Experimental data are compared with theoretical predictions.

**INDEX TERMS:** EMP simulator, hybrid, EM fields, theory, experiment.

Random Effects in Planar Arrays of Thin-Wire Dipoles

A. T. Adams, C. Hsi, and A. Farrar  
Adams and Hsi - Syracuse University; Farrar - formerly  
Syracuse University, IIT Research Institute/ECAC

ACCESSION NO.  
EMCABS 6-81-5

IEEE Trans. EMC, Vol. EMC-20, No. 1, pp 223-232, Feb 1978

**ABSTRACT:** The effects of random errors in the voltage excitation of a planar array of thin-wire dipoles are analyzed. Mutuals are taken fully into account. The method of moments is applied iteratively in conjunction with a random-sampling process, to obtain mean far-field beam patterns and their expected variation, as well as several "expected-gain" quantities. Sinusoidal expansion and weighting functions are used. Block-Toeplitz impedance redundancies and the zeros of the excitation matrix are utilized in an efficient solution routine. Separate array analysis at fundamental and harmonic frequencies yields expected ratios of harmonic to fundamental levels. The theory is outlined and typical results of computation are presented. There is a tendency, due to mutuals, to point the beam near broadside even when the phase is completely random. Significant gain degradation is predicted at harmonic frequencies.

**INDEX TERMS:** Thin wire, planar array, excitation, random error, pattern variation.

Electromagnetic Interference from Electric Arcs in the Frequency Range 0.1 - 100 MHz

D. Klapas, H. Apperley, R. Hackan, and F. A. Benson  
Klapas, Hackam, and Benson - University of Sheffield;  
Apperley - British Rail Technical Centre, Derby.

ACCESSION NO.  
EMCABS 6-81-6

IEEE Trans. EMC, Vol. EMC-20, No. 1, pp 198-202, Feb 1978

**ABSTRACT:** The electromagnetic interference (EMI) from various forms of electrical discharges was investigated, and the measured levels were compared with civilian and military statutory limits of interference. The more stable arc forms, such as moderate-current (50-250A) arcs in argon flow, gave low levels of EMI conforming with all statutory limits throughout the frequency spectrum (0.1-1000 MHz). The interference from high-frequency/high-voltage spark discharges, used for arc initiation, was found to exceed statutory limits if used on a continuous basis.

**INDEX TERMS:** EMI, arcs, stationary, rotating, argon, air, HF sparks



# EMP Coupling to Power Lines

E. Scharfman, E. F. Vance, and K. A. Graf  
SRI International

ACCESSION NO.  
EMCABS 6-81-7

IEEE Trans. EMC, Vol. EMC-20, No. 1, pp 129-135, Feb 1978

**ABSTRACT:** A transmission line model of coupling to power lines has been developed that shows the effect of ground conductivity, angle of arrival, polarization, and power line geometry on the open-circuit voltage at the end of the line. With this information, and the characteristic impedance of the line, the current and voltage to any termination may be calculated. This theory has been checked and shows quite good agreement with values of current measured on scale models of power lines. The soil conductivity was scaled appropriately. The results show that at the highest frequencies of interest, the error introduced by the transmission-line approximation is less than the experimental error ( $\approx \pm 10$  percent). Measurements made of the propagation of pulses down lines show effects of attenuation, dispersion, junctions, bends, and spurs. Where available, theoretical calculations have been compared to measured results. It is concluded that transmission-line models can be used to adequately predict propagation effects.

**INDEX TERMS:** Powerlines, EMP coupling, scale models.

# Statistical Correlation Between Conducted Voltages on the Powerline and Those Measured With A Line-Impedance Stabilization Network

John A. Malack  
IBM Corporation

ACCESSION NO.  
EMCABS 6-81-8

IEEE Trans. EMC, Vol. EMC-20, No. 2, pp 346-349, May 1978

**ABSTRACT:** In measurements of physical parameters, it is not always possible to obtain consistent results because of the dependence on and interaction of a significantly uncontrolled variable element in the measurement. For consistent results to be obtained, the variation in the element may be eliminated by replacing the element with a simulated representative constant. Measurement of conducted powerline noise from electric/electronic equipment is subject to such variation. This paper explores the correlation between conducted noise voltages measured in a LISN configuration and the actual noise voltages expected to be impressed on the power distribution system. The analysis is conducted at 1 MHz. The paper analytically relates the impedances of the LISN, power distribution system, and equipment. A LISN of the type used in the United States is in the development; however, the concept and procedure presented is applicable to any LISN, frequency, and equipment.

**INDEX TERMS:** Conducted noise, statistical correlation, powerlines, line-impedance stabilization network

# Finite Length Cylindrical Scatterer Near Perfectly Conducting Ground - A Transmission Line Mode Approximation

Thomas H. Shumpert and Dennis J. Galloway  
Shumpert-Auburn Univ.; Galloway-Formerly Auburn Univ.,  
now Dynetic, Inc.

ACCESSION NO.  
EMCABS 6-81-9

IEEE Trans. EMC, Vol. EMC-20, No. 1, pp 145-151, Feb 1978

**ABSTRACT:** A Pocklington type integro-differential equation, possessing an exact kernel, is formulated in terms of a complex frequency for the current induced on a thin finite-length cylindrical scatterer which is above, near, and parallel to a perfectly conducting ground plane. The circumferential variation of the axial current is assumed to be described by a transmission line mode approximation when the scatterer is near the ground plane. The equation is reduced to a system of algebraic matrix equations through application of the method of moments. The singularity expansion method is used to determine the transient current response of the cylindrical scatterer to a unit step incident plane wave. Complex natural frequencies, vectors, normalization coefficients, and induced currents are compared to those found through a similar procedure with an approximate kernel. The exact kernel is shown to be necessary when the thin cylindrical scatterer is near the ground plane.

**INDEX TERMS:** Cylindrical scatterer, finite length, perfectly conducting ground, transmission line mode approximation

# Frequency-Sharing and Spread-Spectrum Transmission With Large Relative Bandwidth

Henning F. Harmuth  
The Catholic University of America

ACCESSION NO.  
EMCABS 6-81-10

IEEE Trans. EMC, Vol. EMC-20, No. 1, pp 323-239, Feb 1978

**ABSTRACT:** Radio transmission has been based traditionally on the concept of a small relative frequency bandwidth, which permits the use of circuits and structures that resonate with sinusoidal functions. This approach created no problems until high-resolution radar advanced to pulse durations in the order of 1 ns, and spread-spectrum transmission to frequency bands in the order of 100 MHz. The use of small relative frequency bandwidth in these cases requires operation at frequencies above 10 GHz, where absorption by rain and fog as well as high noise temperature become problems. Concepts and equipment that allow operation with a large relative bandwidth make possible operation of very high resolution radar and spread-spectrum transmission in the most desirable range of a few hundred megahertz to about 10 GHz. This paper explains primarily the motivation for the development of equipment handling large relative bandwidths, since the equipment itself has already been described and is available.

**INDEX TERMS:** Wide bandwidths, spread-spectrum, frequency-sharing, nonsinusoidal signals

# Microwave Radiation-Pattern Measurements in the Presence of Biological Specimens

J. Bigu Del Blanco and C. Romero-Sierra  
Queen's University, Kingston

ACCESSION NO.  
EMCABS 6-81-11

IEEE Trans. EMC, Vol. EMC-20, No. 1, pp 248-258, Feb. 1978

**ABSTRACT:** Power density is used extensively as an index of hazard to living systems from microwave radiation. To assess this, the biological effect observed in test specimens is related to power density as measured in the absence of the specimens. The usefulness of power density as a biologically meaningful parameter has often been questioned and other alternatives have been proposed. In this paper, the authors show the restricted applicability of power density as an indicator of both biological hazard and beneficial effects caused by microwave fields. Power density measurements, at X-band microwave frequencies, were carried out in an anechoic chamber. Measurements were conducted in the absence and in the presence of biological specimens, with the aid of an isotropic microwave probe. Dramatic differences in the radiation patterns were observed, attributable to the large disturbance introduced by the biosystem on the imposed electromagnetic fields. Thermographic analysis (IR scanning) and microwave radiometry complemented the investigation.

**INDEX TERMS:** Radiation patterns, microwave, biosystems.

# Shielding Theory of Enclosures with Apertures

Horacio A. Mendez  
IBM Corporation

ACCESSION NO.  
EMCABS 6-81-12

IEEE Trans. EMC, Vol. EMC-20, pp 296-305, May 1978

**ABSTRACT:** This paper develops the theory of EM radiation from metallic enclosures with apertures, excited by an internal source at frequencies below the fundamental resonance of the enclosure. The enclosure is analyzed both as a cavity with a small aperture in a wall, and as a waveguide section short-circuited at one end and open at the other. Using dyadic Green's functions, the fields generated inside the enclosure are determined. The fields radiated through small apertures in a cavity are determined using Bethe's theory of diffraction by small holes. The radiation from an open waveguide is calculated with the help of field-equivalence theorems assuming evanescent waves. The resulting insertion-loss expressions are numerically evaluated for some representative cases, and graphically compared with a series of measurements performed to obtain experimental confirmation. Very good agreement is obtained in all cases, establishing the validity of the analysis.

**INDEX TERMS:** Shielded enclosures, apertures, insertion loss, below resonance.



Linear and Nonlinear EMP Diffusion Through A Ferromagnetic Conducting Slab

William J. Karzas and Tse Chin Mo  
R&D Associates, Marina del Rey

IEEE Trans. EMC, Vol. EMC-20, No. 1, pp 118-129, Feb 1978

ACCESSION NO.  
EMCABS 6-81-13

**ABSTRACT:** The penetration of an EMP field through a ferromagnetic conducting slab made of iron or steel is investigated. The diffusion of the electromagnetic field in the highly conducting slab is complicated by the presence of the non-linear saturation of the ferromagnetic permeability  $\mu$ , due to the large amplitude of the incident EMP. First we solve analytically the one-dimension plane-wave incidence problem for a slab with a constant  $\mu$ , cylindrical-wave incidence problem by an approximate but extremely useful analysis. These results, shown to bear a simple relationship to those for the one-dimension problem, enable the use of the one dimension results to predict easily the penetrated fields caused by a cylindrical incident current. Then for the nonlinear  $\mu$  case, we justify and extend that relationship by which the behaviors of the cylindrically diffused fields are obtained from those numerical results of the one-dimensional problem.

**INDEX TERMS:** Ferromagnetic conducting slab, EMP diffusion linear, nonlinear.

Variation of Atmospheric Noise with Sunspot Number During the 1600-2000 Hours Time Period at Delhi

P. J. Joglekar and R. A. Agarwala  
Prof. Joglekar & Assoc., Bombay; Regional Engrng. College, Kurukshetra

ACCESSION NO.  
EMCABS 6-81-14

IEEE Trans. EMC, Vol. EMC-20, No. 1, pp 202-206, Feb 1978

**ABSTRACT:** Atmospheric noise data collected by the ARN-2 recorder at Delhi were examined to study the effect of sunspot number (SSN) on the year-to-year variations in the noise levels during 1600-2000 h. Since ionospheric propagation characteristics and thunderstorm activity undergo systematic hour-to-hour changes during this time period, the data were analysed on an hourly basis. The burst-noise-level data collected for one complete year were used for determining probable source locations and modes or propagation. The analysis showed that there is dependence on SSN when the noise is received in the burst form via the ionosphere. When the noise is not received in the burst form, the scatter of points is random, and contamination in the data is suspected. When noise is received from local thunderstorms by a ground wave, there is no clear evidence of any relationship between atmospheric noise and SSN.

**INDEX TERMS:** Atmospheric noise, sunspot number, 1600-2000h.

Evaluation of Relay Suppression Circuits for Reducing EMI

Mirko D. Matejic  
Institut Mihailo Pupin, Belgrade.  
IEEE Trans. EMC, Vol. EMC-20, No. 1, pp 207-210, Feb 1978

ACCESSION NO.  
EMCABS 6-81-15

**ABSTRACT:** The objective of the work described in this paper is to make a comparison of various suppression circuits, connected across the relay, for reducing electromagnetic interference, considering also the effect of relay armature release time (dropout delay time). Tested suppression circuits described in this paper are diode, diode with Zener diode (two cases with different Zener voltages) diode with resistor, and capacitor. Radiated and conducted noises were measured at frequencies up to 1 MHz. Experimental data, supporting analysis and conclusions are presented.

**INDEX TERMS:** Relay, suppression circuits, comparison, experimental.

A Technique for Determination of Filter Insertion Loss as a Function of Arbitrary Generator and Load Impedances

Sadegh M. Vakil

Arya-Mehr University of Technology, Tehran

IEEE Trans. EMC, Vol. EMC-20, No. 2, pp 273-278, May 1978

ACCESSION NO.  
EMCABS 6-81-16

**ABSTRACT:** Insertion loss is derived in terms of generator impedance, load impedance, and filter open-circuit and short-circuit impedances. This expression contains a difference term which places great weight on the accuracy with which filter impedances are measured. It is shown that the use of this difference term can be avoided by introducing the filter insertion loss in a circuit with known generator and load impedances. The resulting exact expression contains terms which are easily measurable with sufficient accuracy to provide reliable insertion-loss values for the filter for any combination of generator and load impedances. Also shown is a simplified approximate expression for insertion loss which is applicable in a filter attenuation band. A discussion of experimental verification of the expressions is followed by curves showing application of the approximate insertion-loss expression to a particular filter.

**INDEX TERMS:** Filters, insertion loss, impedance.

Solution of the Transmission-Line Equations for Three-Conductor Lines in Homogeneous Media

Clayton R. Paul  
University of Kentucky

IEEE Trans. EMC, Vol. EMC-20, No. 1, pp 216-222, Feb 1978

ACCESSION NO.  
EMCABS 6-81-17

**ABSTRACT:** Formulas are obtained for the terminal voltages of a transmission line consisting of three conductors immersed in a homogeneous medium. No simultaneous equations need be solved and the result does not require that the line be electrically short. Typical applications are lines composed of three wires, two wires above a ground plane, and two wires within a cylindrical shield. Certain interesting properties of the solution are also obtained.

**INDEX TERMS:** Transmission lines, three conductors, coupling, formulas

Multiple-Pin Connector With Internal Surge Protection

Cerd E. Keiser and Leon C. Lesinski  
GTE Sylvania, Inc.

IEEE Trans. EMC, Vol. EMC-20, No. 1, pp 211-215, Feb 1978

ACCESSION NO.  
EMCABS 6-81-18

**ABSTRACT:** The design and performance characteristics of a multiple-pin electronic surge arrester (Bulk ESA) are described. This device is a simple compact unit providing electromagnetic pulse (EMP) and lightning protection of systems in which many signal lines enter sensitive electronic equipment. Since it takes one device to protect each wire entering a system, the efficient packaging of the Bulk ESA provides a surge arrester which has the advantages of space saving, low cost, and simplified assembly over the use of current protective devices which range from diodes to large spark gaps. The Bulk ESA protector developed is a sealed chamber containing 53 in-line spark gaps. Each end of the chamber contains a standard 53-pin connector. The sealed chamber is filled with argon gas at 12-mm pressure, to which a trace of radioactive gas is added to stabilize the breakdown and enhance the fast rise response. The Bulk ESA can be integrated with an EMI filter-pin connector which can improve the performance of the Bulk ESA.

**INDEX TERMS:** Filter, surge arrester, transient suppressor, spark gap, EMP, EMI, connectors, filter-pin connector.



Probability Distribution of CW Induced Currents on Randomly Oriented Subresonant Loops and Wires  
William R. Graham and Tse Chin Mo  
R&D Associates, Marina del Rey  
IEEE Trans. EMC, Vol. EMC-20, No. 1, pp 107-117, Feb 1978

ACCESSION NO.  
EMCABS 6-81-19

**ABSTRACT:** The deterministic prediction of both transient and CW field coupling to large complex electrical systems poses such a formidable problem that other approaches to predicting the coupling may be useful. The continuous wave coupling to a complicated electrical system is analyzed in terms of random small dipole interactions in the low-frequency limit (wavelengths  $\gg$  system components' sizes). Both random coupling to the incident wave and random interactions among the dipoles are considered. The variables being randomized are the incident direction and polarization, the sizes and orientations of the dipoles, the mutual coupling strengths, and the lumped load impedances. The resulting normalized current distributions are shown to be insensitive to the details of the model except at the extremely low and high percentiles. The magnetic dipole case is investigated in detail. Its result provides insight into some recent measurements obtained for EMP transient field coupling to large systems.

**INDEX TERMS:** Loops, wires, subresonant, random orientation, CW induced currents, probability distribution

Field-Strength Measurement of Microwave-Oven Leakage at 915 MHz  
Richard A. Tell  
U.S. Environmental Protection Agency  
IEEE Trans. EMC, Vol. EMC-20, No. 2, pp 341-346, May 1978

ACCESSION NO.  
EMCABS 6-81-20

**ABSTRACT:** Measurements of electric field strength of microwave emissions from microwave ovens in the 915 MHz industrial-scientific-medical (ISM) band are reported. Field strengths were determined at 10 and 1000 ft under laboratory conditions and in the vicinity of two large condominium buildings, containing 385 ovens, in Ft. Lauderdale, Florida. Monitoring equipment consisted of dipole and log-periodic antennas feeding the input of a spectrum analyzer which was interfaced to a minicomputer system for automatic data acquisition and analysis. Under controlled conditions, the tested oven produced maximum field strengths of 123.5 dB $\mu$ V/m and 81.0 dB $\mu$ V/m at distances of 10 and 1000 ft, respectively. Fields as high as 79.0 dB $\mu$ V/m were observed at the Florida location, approximately 500 ft from the buildings. Additional measurements were made of band occupancy and the effects of load placement in the oven, orientation of the oven, and polarization of the emerging fields.

**INDEX TERMS:** Microwave oven, leakage, 915 MHz, measurements.

A Three Dimensional Finite-Difference Solution of the External Response of an Aircraft to a Complex Transient EM Environment  
Part II-Comparison of Predictions and Measurements  
Karl S. Kunz and Kuan-Min Lee  
Mission Research Corporation  
IEEE Trans. EMC, Vol. EMC-20, No. 2 pp 333-341, May 1978

ACCESSION NO.  
EMCABS 6-81-21

**ABSTRACT:** Experimental charge and current measurements have recently been performed on an aircraft when it was exposed to the transient electromagnetic field of an electromagnetic-pulse (EMP) simulator. These new data allow a test of the predictive capabilities of the three-dimensional finite-difference method for realistic aircraft-simulator-test problems. Comparisons made between measurements and predictions show that the three-dimensional finite-difference technique provides reasonably accurate predictions for the induced currents and charges on a complex object responding to an applied transient electromagnetic field in the presence of a lossy earth.

**INDEX TERMS:** Aircraft external response, transient EM environment, predictions, measurements.

A Three-Dimensional Finite-Difference Solution of the External Response of an Aircraft to a Complex Transient EM Environment  
Part I - The Method and Its Implementation. K.S. Kunz&K.M. Lee  
Mission Research Corporation  
IEEE Trans. EMC, Vol. EMC-20, No. 2, pp 328-333, May 1978

ACCESSION NO.  
EMCABS 6-81-22

**ABSTRACT:** Experimental charge and current measurements have recently been performed on an aircraft when it was exposed to the transient electromagnetic field of an electromagnetic pulse (EMP) simulator. These new data allow a test of the predictive capabilities of the three-dimensional finite-difference method for realistic aircraft simulator test problems. In the paper, the workings of the three-dimensional finite-difference method and its required inputs and sensitivity to variations in the inputs are discussed in sufficient detail to enable others to employ the method. A companion paper compares the experimental measurements to predictions for a large variety of measurement locations. Agreement is shown to be good for all major response measurements and satisfactory for a number of other measurements.

**INDEX TERMS:** Aircraft external response, transient EM environment, analytical method.

Technical Considerations for Establishing Requirements Pertaining to Broad-Band EMI from Data Processing Equipment & Office Machines  
J. R. Engstrom, J. A. Malack, and I.E. Rosenbarker  
IBM Corporation  
IEEE Trans. EMC, Vol. EMC-20, No. 2 pp 313-320, May 1978

ACCESSION NO.  
EMCABS 6-81-23

**ABSTRACT:** This paper extends the scope of earlier narrow-band work to include control of broad-band emission sources which can exist independently of, or in conjunction with, narrow-band sources in electronic data-processing (EDP) and office machine (OM) equipment (products). While both narrow-band and broad-band noise sources have the potential for RF interference with communication services, our experience with broad-band problems has shown this class of sources to be much less significant than the low incidence of actual narrow-band component EDP interference problems examined in the initial paper (1). Limits are discussed considering the empirical data base and need for international harmonization of interference requirements.

**INDEX TERMS:** Broad-band EMI limitations, electronic data processing, office equipment, rationale.

A Spectrum-Amplitude Approximation for Slowly Varying Non-Linear Frequency-Modulated Pulses of Long Duration  
K.S. Kinz, J.S. Ressman, Jr., and H.J. Wagon  
Kinz-formerly BDM Corp. now Mission Research Corp.; Ressman and Wagon-BDM Corp.  
IEEE Trans. EMC, Vol. EMC-20, No. 2, pp 320-327, May 1978

ACCESSION NO.  
EMCABS 6-81-24

**ABSTRACT:** A spectrum-amplitude approximation is derived for slowly varying amplitude-modulated and non-linearly frequency-modulated pulses of long duration (by "long duration" we mean, essentially, "containing many oscillations"-perhaps thousands-irrespective of the absolute length of the pulse in seconds). The derivation consists of the application of Parseval's theorem to the waveform of interest, approximated by a sequence of linearly frequency-modulated pulses of constant amplitude. It is found that successful application of the approximation depends on the individual pulses being long enough for the changing frequency so that there is little overlap between the spectrum of one segment and that of another. Actual application of the technique can be made with a nominal average frequency from each segment. The technique is demonstrated on an experimental pulse of approximately 20,000 oscillations varying from 500 MHz down to 13 MHz in 960 $\mu$ s.

**INDEX TERMS:** Nonlinear FM pulses, slowly varying AM, Spectrum amplitude, approximation technique.



Some Aspects of Valid EMC Testing of Missiles

L. L. Tsai, T.K. Wu, R.D. Darone, and G. L. Brown  
Tsai, deceased, formerly U. of Mississippi; Wu, U. of Mississippi; Darone & Brown, Army Missile Command, Redstone. IEEE Trans. MEC, Vol. EMC-20, No. 2, pp 306-313, May 1978

**ABSTRACT:** Integral-equation and numerical techniques are used to determine guidelines in valid electromagnetic compatibility (EMC) testing of missiles. Both thin-wire and body-of-revolution modeling are used. Investigated are two primary aspects. 1) If a near-zone source is used rather than plane-wave incidence, how far must the source be for valid simulation, and 2) how significant is the presence of the rocket exhaust (or plume) in determining subsystem response, and need it be included for valid EMC testing? The simulation validity conclusions reached for the models without apertures apply directly as well to the real-life body with apertures. Numerical results are given over the frequency range of 50-200 MHz to help establish guidelines on testing validity.

**INDEX TERMS:** Missiles, EMC testing, 50-200 MHz.

Two Parallel Terminated Conductors in External Fields

K. S. H. Lee  
Dikewood Corporation

IEEE Trans. EMC, Vol. EMC-20, No. 2, pp 288-296, May 1978

**ABSTRACT:** New equations are derived for voltage and current on two parallel conductors terminated with arbitrary impedances and immersed in external fields. By examining several pertinent static boundary-value problems, it is shown that the source terms of the equations can be split into two parts; one part is directly proportional to the transverse components of the magnetic and electric fields of the incident wave, and the other part is attributable to the unequal size of the two conductors. It is also shown that only one two-dimensional static boundary-value problem need be solved for the determination of the coefficients and source terms in the new equations. Detailed calculations are given for two parallel terminated cylinders. Some simple examples are worked out, and the results based on the new equations are contrasted with those derived from the conventional theory.

**INDEX TERMS:** Two parallel terminated conductors, external fields, common-mode current, transmission-mode current, contrast with former theory.

Artifacts in Energy Dispersive X-Ray Spectrometry in the Scanning Electron Microscope (II)

C. E. Fiori and D. E. Newbury  
National Bureau of Standards, Washington, DC

Proceedings of Annual Review of Scanning Electron Microscopy, Chicago, IL, 20-24 Apr 80, Paper in Scanning Electron Microscopy, p251-258 1980 PB81-126237, not available NTIS

**ABSTRACT:** The quality of x-ray spectra obtained with an energy dispersive x-ray spectrometer on an electron beam instrument can be severely compromised by the presence of electromagnetic interference.

**INDEX TERMS:** X-ray spectra, spectrometer, electron beam instrument, electromagnetic interference.

A Supplementary EMC Analysis of the Proposed Airport Surface Detection Equipment (ASDE-3) Radar

G. Larry Brown

IIT Research Institute, Annapolis, MD.

Final Rept. Oct. 79-Aug 80, 30p, ECAC-CR-80-044, FAA-RD-80-123, Contracts F19628-78-C-0006, DOT-FA77WAI-778. Supplement to Rept. No. FAA-RD-77-183, AD A054 607. AD-A092 965/3 PC A03/MF A01. NTIS

**ABSTRACT:** This report supplements information in an earlier report which identified electromagnetic compatibility (EMC) problems associated with the deployment of Airport Surface Detection Equipment (ASDE-3) Radars at a number of proposed sites in the United States. Subsequent to the earlier study, several operational parameters of the ASDE-3 radar have been modified in a direction to lessen the probability of causing or receiving interference, thereby, necessitating a re-analysis of portions of the earlier study. As before, interfering signal levels are compared against established receiver thresholds to determine operational compatibility and frequency management techniques are identified as a solution to potential interference cases, where applicable.

**INDEX TERMS:** EMC Analysis, electromagnetic compatibility, Airport Surface, interference, compatibility, frequency management.

The Federal Aviation Administration Lightning Protection Modules Designed for Leadless Devices

Richard M. Cosel and Manuel Figueroa

Rome Air Development Center, Griffis AFB, NY

FAA-RD-80-119, Contract DOT-FA72WAI-356, AD-A091 642/9, PC A03/MF A01, NTIS

**ABSTRACT:** The silicon avalanche diode transient suppressor is widely used to protect low level solid state devices against voltage transients. There has been a problem, however, in providing suitable low loss, low inductive installation mountings especially in retrofit cases. This report describes two mounting systems developed for the FAA, a barrier strip designated FA9455, for direct current, pulsed or audio lines and coaxial holder designated FA9479 for 50 or 72 ohm video or F.R. lines. Tests were performed using both conventionally constructed suppressors and low capacity units at voltage ratings varying from 6.8 volts to over 50 volts and including bipolar and unipolar devices. Square wave tests on the barrier strip insertion loss tests on the coaxial module and surge testing of both modules indicated that within test parameters, the devices are limited only by the capabilities of the square suppressor used, i.e., they are device limited.

**INDEX TERMS:** Lightning Protection, silicon avalanche diode, transient suppressor, voltage transients, insertion loss, surge testing.

Interference Caused by Television Receivers to Reception at 200 kHz

D. J. Whythe

British Broadcasting Corporation, Kingswood, England

BBC-RD-1980/10, N81-11279/9, PC A02/MF A01

Sept. 80, 11p, NTIS

**ABSTRACT:** A survey of the degree and widespread nature of the interference caused by television receivers to Radio 4 reception on 200 kHz is described. Seventy five fully completed questionnaires were received from locations spread widely over the UK. The survey showed that 58 of those 75 questionnaires reported an impairment to 200 kHz reception which, on average, exceeded one grade on the CCIR 5 point impairment scale, when the 200 kHz receiver was within 3 m from the television receiver but that the effect reduced rapidly with distance, the average impairment becoming only about one half grade when the receivers were 5 m apart. On the other hand, partition walls of brick or stone built houses provided negligible protection. Monochrome and color television receivers caused similar degrees of interference. No individual make or model appeared to be either particularly good or particularly bad.

**INDEX TERMS:** Interference, television receivers, Reception at 200 kHz.



Performance Degradation of A 7400 TTL NAND Gate Due to Sinusoidal Interference.

Jacob Alkalay and Donald D. Weiner.

Syracuse U., NY

Final technical rept. Jun. 79-Jun. 80. 76p, RADC-TR-80-257

Contract F30602-78-C-0083, AD-A091 745/0 PC A05/MF A01, NTIS

**ABSTRACT:** The investigation reported herein addresses the problem of electromagnetic susceptibility of digital circuits. Of particular interest is the desire to obtain electromagnetic interference (EMI) performance curves for digital circuits. This report describes an effort devoted to the electromagnetic susceptibility of a single integrated circuit 7400 TTL NAND gate. The investigation was carried out by means of a computer simulation using the computer program SPICE (Simulation Program with Integrated Circuit Emphasis). The report concentrates on the special case of sinusoidal interference inject at various circuit nodes. Under appropriate conditions the gate voltages and currents were observed to suffer severe waveform distortion. The computer simulation revealed that the sinusoidal interference could cause the propagation delays and the rise and fall times of the output waveforms to increase significantly.

**INDEX TERMS:** Electromagnetic susceptibility, electromagnetic interference, digital circuits, computer simulation, sinusoidal interference.

ACCESSION NO.  
EMCABS 6-81-31

EMP Coupling to Ships

F.J. Deadrick, H.S. Cabayan, K.F. Kunz, R.M. Bevensee, L.C. Martin

Lawrence Livermore Lab. California U., Livermore, CA

Contract W-7405-ENG-48, Jan 80, 163p

UCRL-52803 PC A08/MF A01, NTIS

**ABSTRACT:** Scale-model tests were conducted to establish the adequacy and limitations of model measurements as tools for predicting electromagnetic pulse (EMP) coupling voltages and currents to the critical antennas, cables, and metallic structures on ships. The scale-model predictions are compared with the results of the full-scale EMP simulation test of the Canadian ASW ship, HMCS Huron. (The EMP coupling predictions in this report were made without prior knowledge of the results of the data from the HMCS Huron tests.) This report establishes that the scale-model tests in conjunction with the data base from EMP coupling modules provides the necessary information for source model development and permits effective, low-cost study of particular system configurations. 184 figures, 9 tables (ERA Citation 05:035785)

**INDEX TERMS:** Scale-model tests, electromagnetic pulse, coupling, EMP simulation

ACCESSION NO.  
EMCABS 6-81-32

Corona from Ice, Thunderstorm Electrification and Lightning Suppression

J. Lathan

Univ. of Manchester Inst. of Science & Technology (England)

Final Rept. Nov 80, 20p, AFOSR-TR-80-1285 GRANT AFOSR-77-

3429, AD-A093 128/7 PC A02/MF A01 NTIS

**ABSTRACT:** Five distinct avenues of research relating to thunderstorm electrification are presented: Airborne Studies of Thunderstorm Electrification details some results of the three-year Thunderstorm Research International Project (TRIP); Charge Transfer Accompanying Collisions Between Hailstones and Supercooled Raindrops in the Presence of an Electric Field; Charge Transfer Accompanying Individual Collisions Between Ice Particles, Surface Potential Steps and Their Role in Thunderstorm Electrification; The Growth of a Positive Streamer System; Laboratory and Theoretical Studies of the Raingush Phenomenon. The last four sections above are summaries of laboratory experiments conducted at the University of Manchester Institute of Science and Technology.

**INDEX TERMS:** Corona, lightning, suppression

ACCESSION NO.  
EMCABS 6-81-33

Parameter Estimation from Noisy Transient Electromagnetic Measurements

D.T. Gavel, J.V. Candy, D.L. Lager

California U., Livermore. Lawrence Livermore Lab.

Contract W-7405-ENG-48, 35p, CONF-800842-1, Nuclear EMP

Meeting, Anaheim, CA, Aug 1980, UCRL-84437, NTIS

**ABSTRACT:** The study of the EMP phenomenon has promoted the development of techniques to investigate transient electromagnetic response data. Characterization of the EMP transient response information is necessary to evaluate the performance of that system in a hostile environment. An efficient technique to characterize this performance is to fit an electromagnetic model to the data. The performance of three different signal processing techniques applied to parameterize a body from noisy experimental electromagnetic transient response data is described. The techniques, which range from the well-known Prony method to the more sophisticated extended Kalman filter and finally to the highly sophisticated maximum likelihood identifier, are briefly described. The performance of these algorithms is compared, and their tradeoffs are discussed. 14 figures, 2 tables: (ERA citation 05:035786).

**INDEX TERMS:** EMP, transient electromagnetic response, prony method, Kalman filter, maximum likelihood identifier.

ACCESSION NO.  
EMCABS 6-81-34

Analysis of a Simulated Source of Electromagnetic Pulses  
Master's Thesis

Usto Francis Eugene Schulz

Air Force Inst. of Tech., Wright-Patterson AFB, Ohio

Master's thesis, Feb 80, Rept. No. AFIT-CI-80-4T, 62p NTIS

AD A092 440/7 PC A04/MF A01

**ABSTRACT:** This thesis describes an effort to develop a source of plane wave electromagnetic pulses for use in an experiment which was designed to measure the electromagnetic field strength across an axial slot in an infinite circular cylinder. Two approaches are described. One design approach attempted to simulate a magnetic line source with an array of long monopoles. It was concluded that a source of plane wave pulses could be constructed, but not without degradation in rise time.

**INDEX TERMS:** Simulated, plane wave, electromagnetic pulses, magnetic line source

ACCESSION NO.  
EMCABS 6-81-35

Requirements for Federal EMP Protection Standards for Telecommunications Facilities and Equipment

Chadwick Stansberry

National Communications System, Washington, DC

NCS-TIB-80-4, AD-E100 396, Jun 80 32p. NTIS. See also rpt.nos.

NCS-TIB-78-1, AD-A060 629 & NCS-TIB-80-3, AD-A089 772. AD-A089 773/6 PC A03/MFA01.

**ABSTRACT:** This report identifies three interrelated standardization projects that can lead to the development of Federal EMP protection standards for application to telecommunication facilities and equipment. The purpose and scope of each project is described and provides the necessary focus for understanding the need for additional studies to acquire data for EMP standards.

ACCESSION NO.  
EMCABS 6-81-36

**INDEX TERMS:** EMP Protection, standards, telecommunications



# Shielded Enclosure Test Bed Requirement

L. Valcik, T.A. Martin, I.N. Mindel

IIT Research Inst, Chicago IL

Final Rept. Jan79-Feb 80. DNA-5341F, Apr. 30, 1980, 40p

Contract. DNA001-79-c-0205, AD-A092-589/1, PC A03/MF A01 NTIS

**ABSTRACT:** A shielded enclosure Test Bed Facility is recommended for obtaining data relating EMP shield design to the internal fields and internal cable coupling. The facility should accommodate a shielded enclosure approximately 10 ft high x 20 ft wide x 50 ft long, to study a variety of shield design parameters, e.g., shield panel material and thickness, joint construction, and penetrant configurations. It should provide for excitation by CW injected current and a radiated pulse. Several analytical and laboratory tasks are recommended in support of the test bed experiments.

**INDEX TERMS:** Shielded Enclosure Test, EMP, shield design, cable coupling

# Cost Assessment for Shielding of C3 Type Facilities

L. Valcik

IIT Research Inst. Chicago, Ill.

Final Rept. Jan 79-Feb 80. IITRI-E6465-FR, DNA-5278F

Contract DNA001-79-C-0205 AD-A090 132/2 NTIS

**ABSTRACT:** Costs were estimated for four slightly different designs for an all-welded steel envelope shield to protect a C(3) facility against high-altitude EMP, and for an alternative shield design using overlapping steel sheets joined by power-driven pins and with seams arc sprayed with zinc. The all-welded shields are substantially more expensive because of the high cost of MIG welding.

**INDEX TERMS:** Cost assessment, shielding high-altitude EMP, shield design.

# Electrostatic Protection of the Solar Power Satellite and Rectenna. Part 2: Lightning Protection of the Rectenna.

Rice U. Houston, Tx Final Rpt. Nov 80, 124p, NASA-CR-3345,

Contract NAS8-33023, N81-10526/4, PC A06/MF A01 NTIS

**ABSTRACT:** Computer simulations and laboratory tests were used to evaluate the hazard posed by lightning flashes to ground on the Solar Power Satellite rectenna and to make recommendations on a lightning protection system for the rectenna. The distribution of lightning over the lower 48 of the continental United States was determined, as were the interactions of lightning with the rectenna and the modes in which those interactions could damage the rectenna. Lightning protection was both required and feasible. Several systems of lightning protection were considered and evaluated. These included two systems that employed lightning rods of different lengths and placed on top of the rectenna's billboards and a third, distribution companies; it consists of short lightning rods all along the length of each billboard that are connected by a horizontal wire above the billboard. The distributed lightning protection system afforded greater protection than the other systems considered and was easier to integrate into the rectenna's structural design.

**INDEX TERMS:** Computer simulations, tests, Solar Power Satellite, rectenna, lightning protection.

# Lightning Strike at Bryan, Ohio

B. E. Nichols

Massachusetts Inst. of Tech. Lexington, Lincoln Lab.

Contract AC02-76ET20279, Feb 80, 19p, COO-4094-81 NTIS

PC A02/MF A01

**ABSTRACT:** A week before the 29 August 1979 dedication of the photovoltaic power system at daytime AM radio station WBNO, in Bryan, Ohio, a lightning superbolt struck the FM radio tower, one of two towers at the station. Minor damage to the station and to components of the photovoltaic system, the latter designed by MIT Lincoln Laboratory under U.S. Department of Energy sponsorship, is described. This rare strike suggested the need for increased protection and more voltage-transient suppressors were added to those already in place as a preventive measure in the event that such a phenomenon reoccurs. (ERA citation 05:036449)

**INDEX TERMS:** Lightning, protection, voltage-transient suppressors.

# Compatibility, Electromagnetic

Army Test and Evaluation Command, Aberdeen Proving Ground, MD

Final rept. on test operations procedures, Report No.

TOP-6-2-560, Oct 79, 30p, supersedes Rpt. No. MTP-6-1-006, dtd 31 Jul 70,

AD-876 130, See also Rpt. no. TOP-2-2-613, AD-775 441 and Rpt. no. TOP-6-2-542,

AD-775 446. AD-A078 944/6, PC A03/MF A01, NTIS

**ABSTRACT:** This Test Operations Procedure (TOP) provides methods for determining the electromagnetic compatibility of communications-electronics (C-E) equipment. It describes procedures to determine that C-E equipment and systems incorporate the best available technology for securing freedom from interference and that concepts for their use assure mutual compatibility with the resultant electromagnetic environment.

**INDEX TERMS:** Test operations, EMC, equipment compatibility, interference, EM environment

# A Comparison B'n E.Fld. Strengths Similarly Gen. & Meas. in the Open Air, in a Shielded Enclosure and in a Large Aircraft Hangar, over 10 to 110 MHz.

M.Dew & F. Harrison

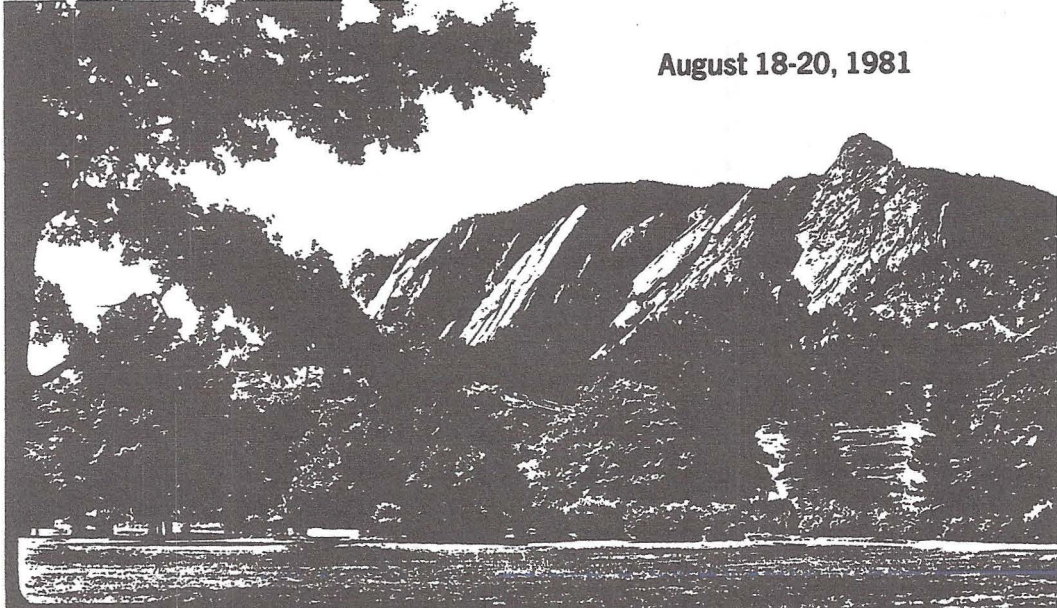
Royal Signals & Radar Establishment, Malvern (England)

RSRE-MEMO-3248, BR73471, Feb. 80, 18p, N81-12353/1 PC A02/MF A01 NTIS

**ABSTRACT:** Field Strength measurements over 10 to 110 MHz were made (in 10kHz bandwidth) using a tracking generator, a spectrum analyzer, and a biconal antenna. The dimensions of the shielded enclosure were 6.1 x 3.66 x 3.0 m, and the concrete floored, metal hangar 80x40x10m. It was found that in each polarization the hangar performance deviated much less from that in the open air than did the shielded enclosure performance. The latter shows deviations with modulus as great as 39 dB (vertical pol) and 26 dB (horizontal pol). For any electric field strength measured in the shielded enclosure the probability that the result would be at least 6 dB different from that similarly obtained in the open air was 38% or 43.5% according to polarization and that when similarly measured in the hangar the corresponding probabilities were 0% and 1%.

**INDEX TERMS:** Electric field strengths, open air, shielded enclosure, large aircraft hangar.





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