IEEE

Electromagnetic Compatibility Society Newsletter

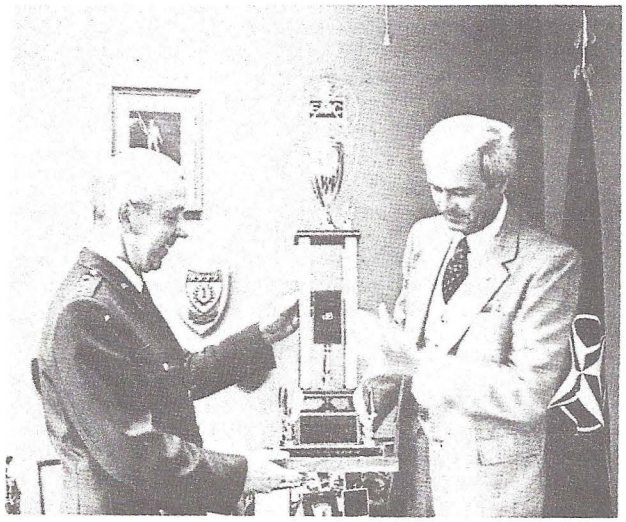
ISSUE NO. 107 FALL 1980 (ISSN 0164-7644) EDITOR: ROBERT D. GOLDBLUM

1980 dB TROPHY AWARDED TO NATO

The dB (Decade Bunch) Society, fraternity of highly qualified electromagnetic engineers, awards annually a travelling trophy to those who have most significantly and prudently contributed to the electromagnetic field.

For the year 1980, the trophy was finally presented to the Military Committee in favour of its Military Agency for Standardization (Air Board/Air Electrical Working Party) on 3 June 1980 at NATO Headquarters, Brussels. The Air Electrical Working Party (AEWP) is actively engaged to standardize within the Alliance aircraft electrical parts, systems and characteristics, and to study systems for generation, conversion, storage, distribution of electrical power for aircraft servicing. Up to date, the AEWP has produced 22 NATO Standardization Agreements (STANGs) and 8 promising studies have been carried on.

On behalf of the Military Committee, the Deputy Chairman, Lieutenant General Faurer, accepted the award and thanked the dB Society for the honour of receiving recognition for the continued endeavours to strive for progress in the field of standardization.



LEFT

Lt. Gen. Lincoln Faurer
Deputy Chairman
Military Committee
NATO-Brussels

RIGHT

John E. Merrell
Secretary
dB Society

IEEE ELECTROMAGNETIC COMPATIBILITY SOCIETY NEWSLETTER is published quarterly by the EMC Group of the Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY 10017. Sent automatically and without additional cost to each member of the EMC Group.

Second class postage paid at New York, N.Y., and additional mailing offices.

FIRST CLASS MAIL

EMC SEMINARS AND COURSES

1. Offered by the George Washington University, Washington, DC 20052, Office of Continuing Engineering Education, Tel.: 202-676-6106:

- "Grounding, Bonding & Shielding," January 5-6, 1981
- "Hazardous Electromagnetic Radiation," January 12-13, 1981
- "Lightning Protection," February 2-3, 1981

All of the above two-day courses will be given at the University. The instructors are A. K. Guthrie, Manager, Mobile Radio Dept., General Electric Co., and Bernhard E. Keiser, Consulting Engineer.

2. Offered by R & B Enterprises, 1050 Colwell Lane, Conshohocken, PA 19428, Tel.: 215-828-6236:

- "Requirements and Testing of Computer Devices per FCC Docket 20780 and 80284," Dallas, October 20; Chicago, November 12; Baltimore, November 17; and, Orlando, November 24, 1980. The instructor of the one-day seminar is Milton C. Mobley, Asst. Chief Engineer, FCC (retired).
- "Designing to Meet FCC Docket 20780," Dallas, November 6; Chicago, November 13; Baltimore, November 18; and, Orlando, November 25, 1980. The instructor of the one-day seminar is Richard J. Mohr, Manager, R&D, Comtech Labs.
- "Understanding and Application of MIL-STD-461B," Dallas, November 7; Chicago, November 14; Baltimore, November 19; and, Orlando, November 26, 1980. The instructor for this one-day seminar is Robert D. Goldblum, President and Technical Director, R & B Enterprises.

3. Offered by Don White Consultants, Inc., State Route 625, P.O. Box D, Gainesville, VA 22065, Tel.: 703-347-0030:

- "Design and Measurement for EMI Control," San Francisco, November 17-20, 1980
- "Introduction to EMI/RFI/EMC," Washington, DC, November 5-7 and San Diego, December 9-11, 1980
- "Grounding and Shielding," Chicago, November 18-20 and Boston, December 2-4-, 1980
- "Lightning Control," Orlando, November 12-13, 1980
- "EMC Design for PCDs and Electronic Modules," Washington, DC, December 11-12, 1980
- "EMC in Power Supplies," Washington, DC, December 8-10, 1980

DEADLINE FOR JANUARY 1981 ISSUE OF THE NEWSLETTER IS DECEMBER 15, 1980

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EMC STANDARDS ACTIVITIES

by Richard B. Schulz

This column on EMC Standards Activities focuses upon activities of the IEEE EMC Standards Committee, EMC activities of RTCA Special Committee 135, and Process Measurement and Control Committee 33 of SAMA.

Institute of Electrical and Electronics Engineers (IEEE)

Scope: The scope of the standardization activities of IEEE falls within the technological field stated in the IEEE Constitution, which is the advancement of the theory and practice of electrical engineering, electronics, radio, and allied branches of engineering. IEEE as a scientific, engineering and educational society, develops and publishes standards in such categories as definitions and terminology; methods of measurement and test; application guides; and recommended practices and safety. These publications fall into three classes:

Standards: Documents with mandatory requirements. They are generally characterized by the use of the verb "Shall."

Recommended Practices: Documents in which procedures and positions preferred by IEEE are presented. They are generally characterized by the use of the verb "should."

Guides: Documents in which alternative approaches to good practice are suggested, but no clear-cut recommendation is made.

EMC Standards Committee

Chairman: Mr. Harold E. Taggart
Natl. Bureau of Standards
US Dept.of Commerce
Boulder, CO 80302
303-497-3462

EMC Interest: EMC aspects of the IEEE scope of standardization activities.

Program: The committee operates with two subcommittees, one for east coast members and the other for west coast members. It is responsible for establishing standards in the EMC area and to determine if the documents should be reaffirmed, require revision, or should be deleted. Standards presently under the cognizance of this committee are:

IEEE No.	TITLE
139(1952)	Recommended Practice for Measurement of Field Intensity (sic) above 300 MHz from Radio-Frequency I.S.M. Equipments
140(1950)	Recommended Practice for Minimization of Interference from Radio-Frequency Heating Equipment
187(1951)	Open-Field Method of Measurement of Spurious Radiation from FM and TV Broadcast Receivers
213(1961)	Methods of Measurement of Radio Interference: Conducted Interference Output to the Power Line from FM and TV Broadcast Receivers in the Range of 300 kHz to 25 MHz
214(1961)	Construction Drawings of Radio-Interference Line Impedance Network
263(1965)	Measurement of Radio Noise Generated by Motor Vehicles and Affecting Mobile Communications Receivers in the Frequency Range 25 to 1000 MHz
299(1969)	Recommended Practice for Measurement of Shielding Effectiveness of High-Performance Shielding Enclosures
376(1975)	Standard for the Measurement of Impulse Strength and Impulse Bandwidth

Radio Technical Commission for Aeronautics (RTCA)

RTCA is an association of aeronautical organizations of the United States from both government and industry. Dedicated to the advancement of aeronautics, RTCA seeks sound technical solutions to problems involving the application of electronics and telecommunications to aeronautical operations. Its objective is the resolution of

such problems by mutual agreement of its member organizations.

The findings of RTCA are in the nature of recommendations to all organizations concerned. As RTCA is not an official agency of the Government of the United States, its recommendations may not be regarded as statements of official government policy, unless so enunciated by the government organization or agency having statutory jurisdiction over any matters to which the recommendations relate.

RTCA SC-135: Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments

Chairman: Mr. Kenneth G. Snyder
MRS Program, Collins Radio Group
Falcon Jet Corporation
P. O. Box 6156
Little Rock, AR 72216
501-372-5829

EMC Interest: Special Committee 135 is concerned with all types of environments concerning airborne equipment, one of which is the EMC environment. It is responsible for an RTCA document on such environments and for participation in international standardization activities in corresponding areas.

Program: The committee recently has reviewed and updated RTCA/DO-160 to RTCA-DO-160A (January 1980) for which the terms of reference were:

Undertook the task of updating RTCA Document DO-160, "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments."
With regard to this updating task, SC-135 coordinated these efforts with the European Organization for Civil Aviation Electronics (EUROCAE) to insure that the updated RTCA/EUROCAE companion documents are in agreement, or, as a minimum, compatible.

Further, attention was given to the related ongoing efforts of the International Organization for Standardization (ISO) Technical Committee 20, Subcommittees 1 and 5 (ISO/TC 20/SC and ISO/TC 20/SC 5), and liaison was conducted to the extent necessary to keep the ISO Group informed of SC-135 progress. Also, members of ISO/TC 20, as appropriate, were invited and encouraged to participate.

Coordination of RTCA/DO-160A was accomplished by RTCA SC-135, the European Organization for Civil Aviation Electronics (EUROCAE) Working Group 14 (WG-14), and the International Organization for Standardization Technical Committee 20, Subcommittees 1 and 5 (ISO/TC 20/SC 1 and ISO/TC 20/SC 5). EUROCAE concurs with RTCA on the Environmental Conditions and Test Procedures set forth.

Present terms of reference are:
Continue liaison with EUROCAE Working Group 14, with the primary task of seeking agreement on test procedures for explosion-proof testing.

Maintain an active group of Change Coordinators to develop coordinated recommendations on issues that may arise after RTCA DO-160A and EUROCAE ED-14A are adopted as de facto International Standards by the International Organization for Standardization (ISO), and to facilitate future updating of DO-160A.

SCIENTIFIC APPARATUS MAKERS ASSOCIATION (SAMA)

Scientific Apparatus Makers Association standards are adopted in the public interest and designed to eliminate misunderstanding between the manufacturer and the purchaser and to assist the purchaser in collecting and obtaining without delay the proper product for his particular need.

Existence of a SAMA Standard or a Proposed SAMA Standard does not in any respect preclude any member or non-member from manufacturing or selling products not conforming with the standard.

PMC 33: Process Measurement and Control Committee 33

Chairman: Mr. L. E. Friedline
Bailey Controls
29801 Euclid Ave.
Wickliff, OH 44092
216-943-5500

EMC Interests: The committee is concerned with the electromagnetic susceptibility of process-control instrumentation.

Program: A SAMA Standard, PMC 33.1 (1978), has been developed and issued under the title, "Electromagnetic Susceptibility of Process Control Instrumentation." This standard applies to the susceptibility of industrial and process-control instrumentation to radiated electromagnetic energy. The standard establishes a classification of environments for anticipated electromagnetic fields and defines test methods for evaluating the instrumentation when used in these electromagnetic environments.

SCHEDULED COMMITTEE MEETINGS

OF MAJOR EMC INTEREST

A majority of the EMC standards committees will have met at the time of EMC '80, and will not have scheduled following meetings until then. Since such timing is incompatible with the deadline for preparation of this column, no schedule is provided for this issue.

CHAPTER CHATTER

by Charles F. W. Anderson

The summer doldrums are just ending, thus, the dearth of news. If I get to Baltimore I'm going to try to meet every Chapter Chairman (or representative) present to get them to send in items for the column.

Los Angeles

Just a few days too late for the summer issue, Mike Malinick sent in a file of the meeting announcements for the LA Chapter for the past couple of years. The diversity of topics and their technical directions sound as if they are doing great things there. Keep up the good work - and please send in your reports!

Fred Nichols, President, LectroMagnetics, Inc., presented a paper on shielded enclosures at the Chapter meeting on September 18th.

Eastern Shore

Is there an Eastern Shore Chapter? No one seems for sure. Len Thomas has written to the supposed Chairman of the Chapter to find out what's what. If there is such a Chapter, how about some information, so that we can publish it.

Central New England

On September 25th, The Chapter co-sponsored a meeting in conjunction with the MTT Chapter. The topic was "Noise Effects in Millimeter Wave Solid-State Sources," presented by Dr. J. Ondria of Alpha Industries. Their October meeting will feature John Dobmeier and Joseph Neleski of IITRI's EMC IAP Support Group speaking on "Computer-aided Intrasystem EMC Modeling and Analysis." Plans for future meetings include such topics as VDE, CISPR and new FCC requirements; and, also test methods and standards for radiated EMI originating in SCR-controlled propulsion systems. John is intimately involved in the development of the latter. Chapter Vice Chairman, Chet Smith, is General Chairman for the 1985 EMC-S Symposium and he was planning to meet with other Symposium committee members during the Baltimore gathering.

Japan

As usual, Professor Sato has sent us lists of papers presented at the EMC meetings in Japan. Eleven papers were given at a meeting in June in Nagasaki and ten were presented at a meeting in Akita early in July. Topics ranged from highly theoretical to quite "down-to-earth," including "Environmental Effects of Electrostatic Fields Underneath Transmission Lines."

Central Florida

No, there is not a Central Florida Chapter - yet. Yes, there is a possibility of the formation of one. George McClure, Chairman of the Orlando Section (and a G-27 affiliate), and your Column Editor have been planning for an EMI-oriented meeting at which petition signatures would be solicited. It appears that there are now a sufficient number of EMC-S members in the area to make a Chapter possible. The meeting probably will be in November, and the speaker, we hope, will be Bob Hammack, of AT&T's Atlanta Center.

EMCS CHAPTER CHAIRMEN

The following is the list of Chapter Chairmen as our records presently indicate. Chapter officers are requested to send all changes or corrections to:

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RESULTS OF THE BOARD OF DIRECTORS ELECTION BALLOT

As you know, a ballot for the election of six Electromagnetic Compatibility Society members to the Board of Directors was issued on July 25, 1980. The ballots returned have been counted, and the following candidates have been elected for a three-year term beginning January 1, 1981:

Carl C. Allen
Hugh W. Denny
Robert D. Goldblum
Donald N. Heirman
Herbert K. Mertel
Leslie A. (Art) Wall

The IEEE staff wishes the newly elected members to the Board of Directors success and thank all nominees for permitting their names to be included on the ballot.

DUES INCREASES ANNOUNCED BY IEEE

The Board of Directors of the IEEE has approved an increase in basic membership dues of eight dollars to $43, and a two dollar increase to $12 in the U. S. regional assessment, specifically assigned to cover the cost of participation in the American Association of Engineering Societies and the Accreditation Board of Engineering and Technology. Student dues will change from $10 to $12, and dues for students transferring to higher grade membership will be uniformly changed to $22 plus applicable regional assessments in the first year after graduation, with full dues payable the second year.

These actions were taken by the Board at its August 24th meeting. At its meeting in May, the Board approved a seven dollar increase in the assessment for members in Region 8 which consists of Europe, Africa and the Near East. (That portion of Africa transferred into Region 8 in 1980 will be exempt from this assessment in 1981.) This is the first general dues increase since 1976, when a five dollar increase in both basic and U. S. regional assessment was implemented. The new fees are effective with the 1981 dues billing.

The proposed $19.5 million 1981 General Fund budget, which is exclusive of technical society funds, currently shows a deficit of $250,000, although additional budget reviews will likely result in a balanced budget. The target for the 1980 budget deficit, earlier forecast at $1.26 million, has been reduced to $750,000.

FCC OFFICE OF SCIENCE AND TECHNOLOGY REORGANIZED

The Federal Communications Commission has approved reorganization of its Office of Science and Technology (OST), which, under the direction of the Chief Scientist, acts as an advisor to the Commission on characteristics of the radio frequency spectrum, its uses and the types of equipment utilizing the spectrum. OST gathers, analyzes, and uses communications-related scientific and technical data in providing solutions and technical recommendations for decision-making.

Under the reorganization, there will be two deputy chiefs - Deputy Chief for Policy and Deputy Chief for Technology - who will serve as the major management officials through whom the Chief Scientist will manage and direct OST. The Deputy Chief for Policy will be responsible for spectrum management and international activities, and will direct policy formulation, overseeing the effects of long-range planning and of the actions taken in the operating divisions as they affect policy. The Deputy Chief for Technology will manage technical planning, equipment authorizations and standards, and research and analysis activities.

Three divisions will be established to cover the major work areas of the office - examination and approval of equipment (Authorization and Standards Division); spectrum management (Spectrum Management Division); and, research in spectrum propagation and innovations in the field (Research and Analysis Division).

The Technical Planning Staff will identify and review new developments in telecommunications and related technologies. It will acquire, store and retrieve scientific and technical information for the Commsssion's work and will direct or participate in studies of advanced communications technology.

The International Staff will combine the planning, coordinating, and authorizing responsibilities of the current International Conference Staff with related activities now performed in the Office of Plans and Policy. The staff will handle required public proceedings in preparation for international conferences and will participate, as appropriate, in bilateral and multilateral meetings.

It will conduct surveys and studies to prepare and defend U.S. positions in international discussions and will handle incoming and outgoing materials between the FCC and international bodies or foreign administrations and will maintain an archive of such materials.

The Authorization and Standards Division will be responsible for equipment authorizations, testing, calibrating and associated functions, including the examination of applications for various types of equipment approval. It will include the Equipment Authorization Branch, the Technical Standards Branch, the Instrumentation Branch, as well as two new branches - the Applications Examining Branch, which will combine the processing functions in one location, and the RF Devices Branch, which will be responsible for equipment coming under Parts 15 and 18 of the Rules.

The Spectrum Management Division will be responsible for domestic and international frequency allocation and coordination functions and associated activities. It will have five branches - Frequency Liaison, Treaty, Spectrum Engineering, Spectrum Planning, and Rules.

The Research and Analysis Division will provide the scientific basis necessary for FCC actions relating to technical issues. It also will bring areas of inadequate technical knowledge to the attention of the Chief Scientist and other Commission staff, and will plan and propose research programs so that timely results can be obtained. It will have three branches - Propagation Analysis, Satellite Systems, and Research.

The staff offices - Policy and Management, Technical Planning, and International - will report directly to the Chief Scientist.

The Policy and Management Staff will provide administrative and policy support, and will coordinate office activities in the areas of personnel, management and budget. This staff also will maintain liason with offices both within and outside the FCC to ensure effective coordination of OST proposals with other agencies, industry and the public.

HOUSE TAKES SMALL STEP TOWARD ENCOURAGING MULTI-YEAR R&D AUTHORIZATIONS

The House has approved, by voice vote, a measure that falls short of providing authority for multi-year approval of R&D; but, does move a step closer by giving Congress information on future R&D fund requests. The bill (H.R. 7689) was approved July 21. According to its sponsor, Rep. Don Fuqua, it is "a pilot endeavor designed to give Congress and the executive more flexibility in handling authorizations. It does not require subcommittees or committees to follow any particular procedure or do anything differently. It does require the executive to submit estimates of its major R&D program for at least two years -- so that committees may authorize for more than one year if they so desire."

Book Reviews

by Jim Hill, EMXX Corporation

We are indebted to two EMC engineers with Martin Marietta, Denver for our book reviews this month. While we were there this summer, we conned Bob Keith and Dave Gonshor into reviewing two of the Don White Encyclopedia Series books. Dave then volunteered a review of the transmission line book which he had recently acquired.

Both Keith heads up the EMC effort on the MX Missile program at Martin Marietta and Dave Gonshor gives him strong support. You may suspect that their reviews are biased slightly by their involvement in the MX program and its area of interest; but, I believe that they have made a fair assessment of these books in their reviews.

"Electromagnetic Ambients and Man-Made Noise"

BY

John R. Herman
Published by Don White Consultants, Inc.
State Route 625, P. O. Box D
Gainesville, VA 22065, 1979

Review by R. M. Keith
Martin Marietta, Denver Division

The preface of this book states that the purpose is "to describe the noise environment in terms of its variation with frequency, location and time, and to identify the types and radiation characteristics of the noise sources which create that environment." This objective has been, for the most part, achieved. The author divides noise into two classes, internal and external to the receiving system, and addresses only the external noise. He further divides the external noise into man-made and natural, with the major emphasis given to radiated man-made noise. He does present a brief overview of natural noise sources in Chapter 1.

With the major emphasis being placed on radiated, man-made noise, one cannot help but notice that much of the data is dated. 13% of the 226 references listed are 1960 or older, and 52% are dated prior to 1970. Only 15% of the references are 1975 or later. It may be that this is the only data available; however, it would have been useful to have a method of accounting for the number of new sources (licensed transmitters, government and private sector) and extrapolating the data to be more indicative of present day electromagnetic levels. Nevertheless, a tremendous amount of material is presented in the 229 pages - almost double the size of the other volumes in the Encyclopedia series. Furthermore, this volume, with its large number of references, is a huge data bank and reference manual for man-made radiated noise sources.

The book contains 4 chapters. Chapter 1 is an overview of electrical noise. The author lists the frequency assignments in the United States, and gives a brief overview of natural noise sources. The waveforms of atmospheric noise at varying distances from a lightning stroke are

from measurements made by Taylor in 1963 which are very different from the current measurement by people such as Krider and Uman that show lightning originated E and H fields with fast (100 ns) risetimes. The many variables describing electromagnetic ambients, including the APD (amplitude probability distribution) are discussed. He sets the stage for the detailed data in subsequent chapters by grouping man-made radio noise into 3 categories: incidental radiation (ignition systems, motors, home appliances, and electric power lines); intentional radiators (licensed transmitters, door-opener transmitters, wireless announcing systems, etc.); and unintentional radiators (cable TV systems, microwave ovens, industrial heaters, RF-stabilized arc welders, and many others). He concludes the chapter with a short summary of composite effects of electromagnetic ambients.

Chapter 2 is devoted entirely to licensed transmitters. The geographic distribution of Radio and TV stations is generated from 1969 and 1971 data. Some representative spectum signatures, AM, FM and TV transmissions, WWV, Radio Navigational Aids, Land Mobile transmitters, and Radar are presented.

Chapter 3 is dedicated to discrete man-made noise signatures. The author states that the two principal sources of man-made noise are vehicular ignition systems and electric power lines. The representative discrete signatures are:

1. High-voltage and extra high voltage transmission lines whose corona discharges extend the radiated noise spectrum as high as 1 GHz.
2. Vehicular ignition noise including the key-in-ignition alarms.
3. Electric cars and trains using SCR speed control systems.
4. Electrical appliances and power tools - the data is vintage 1963.
5. Gaseous discharge lighting systems.
6. Other unintentional radiators such as calculators and electric fences.
7. RF-stabilized arc welders.
8. RF industrial heaters - 1964 data.
9. Microwave ovens, garage door openers, and diathermy equipment.

Chapter 4 is devoted to the electromagnetic ambients which are a composite of all the discrete noise sources within range of the receiving system. The variables are divided into two groups: the physical factors such as separation distance and terrain characteristics, and the noise source factors such as diurnal variations. The author presents a statistical model of the "noise process" and references Middleton's model. Measurements by Boulton are compared to the calculated APD using the Middleton model with remarkable coincidence. Some hitherto unpublished data from Sagamore Hill (Massachusetts) Radio Astronomy Observatory is presented as a function of population density of the towns surrounding the observatory. He concludes with ambient noise data from selected urban areas, and spectrum signatures of various sources. The sources include ambients in industrial centers, commercial office buildings, shopping centers, parks and university campuses, airports and aircraft, residential areas, hospitals, roadways and freeways, rural areas and farms, and coalmines. The only conducted data (power line conducted) is presented for hospitals and a Denver office building.

There is an enormous amount of data presented in the book, and to describe it in more detail would take too much room. The graphs and figures are for the most part good to excellent quality - a few scope photographs could be better. A considerable space is devoted to describing the various measurement techniques, particularly the APD and some pulse techniques. Although the author states that the only way to be absolutely certain of the ambients at any specific location is to measure it, he, nevertheless, presents statistical approaches for calculating ambient levels. The lack of conducted industrial transients, perhaps, can be attributed to the fact that these have been given serious attention by the IEEE power group, and not the EMC community. The book should make a good addition to anyone's library who has a need for a reference source to electromagnetic radiated ambients.

"Lightning and Lightning Protection"

Multivolume EMC Encyclopedia Series
Volume IV

BY

William C. Hart and Edgar W. Malone
Published by Don White Consultants, Inc.
State Route 625, P. O. Box D
Gainesville, VA 22065, 1979
161 Pages, $29.50

Reviewed by D. V. Gonshor
Martin Marietta Corporation
Denver, CO 80201

This book covers a very broad area of the lightning protection problem, and as such, fills a void in lightning literature. The lightning threat, protection device application and maintenance, and verification testing are discussed for ground structures and many types of vehicles. With few exceptions, the book is a thorough introduction to the lightning problem, and is especially valuable to the engineer dealing with lightning for the first time.

The first chapter briefly introduces the lightning phenomenon and contains interesting statistics on lightning occurrence and damage throughout the world. Practical information on how to protect yourself from lightning is given. As indicated in the

text, no attempt is made to be comprehensive. As with most of the chapters, multiple references are given for further investigation of specific areas of interest.

Chapter 2 deals with lightning fundamentals, i.e., types of lightning, thunderstorm day statistics, flash density and frequency of occurrence. This data enables the reader to estimate the number of flashes to be expected annually at a given geographical location.

Chapter 3 contains the heart of the book and describes how to protect against lightning. Extensive data is presented to establish a lightning model for engineering calculations in both time and frequency domains. Many graphs are given to determine the strike incidence to aerial and buried objects. Lightning rods and the familiar cone of protection are introduced. Numerous electrical circuit protection devices including spark gaps, varistors, semiconductors, and hybrid devices are discussed in detail. Guidance is given as to selection of the optimum device for a given application. Notably missing from this chapter are techniques for determining the magnitudes and waveshapes of induced transients in circuits based on the threat and circuit characteristics. However, many analysis techniques are available in the referenced literature. A section on bonding and grounding for lightning protection emphasizes the importance of minimizing inductive voltage in ground conductors and presents techniques for reducing inductance in grounding systems. Electrical power protection for land based systems is discussed and the section provides a checklist for the proper selection of protection devices. The remaining part of Chapter 3 considers protection of communications systems and vehicles (boats, land vehicles, aircraft and missiles). This section could have been far more extensive. For example, the section on aircraft and missiles is minimal (less than a page) and ignores the trend towards use of composite materials for aerospace vehicles.

Chapter 4 deals with design verification testing. Injection testing techniques are given, as well as circuit and device testing waveforms. Of particular interest are the waveform generation circuits presented. Also discussed in this chapter are test procedures, indirect effects testing and specifications for systems and protection devices. This chapter should be very useful for establishing a test program for design verification.

Chapter 5 emphasizes the need for periodic maintenance of protection devices and bonding and grounding systems. Periodic preventive maintenance routines are given and devices susceptible to deterioration are identified.

Chapter 6, along with the last part of Chapter 1, briefly describes on-going research in the areas of EM fields from lightning, thunder, flash optics, physics of lightning formation, and thunderstorm detection. A list of 39 companies contributing information to the book is given, many of which are involved in manufacture of lightning protection products.

A book as wide in scope as this one cannot be expected to provide a great depth of detail in all areas, and this book is no exception. However, many good references are given and the reader is urged to investigate further for greater detail. Overall, this book is an excellent and reasonably complete introduction to lightning and is a valuable reference for most everyone involved in lightning protection.

"Modern Transmission Line Theory and Applications"

BY

Lawrence N. Dworsky
Published by John Wiley and Sons, Inc.
One Wiley Drive
Somerset, NJ 08873
236 Pages, $18.50 Plus
Tax, shipping and handling

Reviewed be D. V. Gonshor
Martin Marietta Corporation
Denver, CO 80201

A solid understanding of transmission line theory is essential to the EMC analyst so that he may successfully deal with today's advanced circuitry and utilize modern EMC analysis techniques. This book presents the latest techniques for analyzing transmission line properties of various materials and geometries. Although emphasizing properties of microstrip and stripline circuits, the methods can be used for all types of circuit configurations where, at high enough frequencies, the circuit behaves with transmission line properties.

As expected, the book begins with a presentation of basic transmission line theory. The treatment is brief, but much more complete than that found in many introductory field theory books. The reader should have a prior understanding of basic transmission line theory and the concepts of distributed circuits and wave propagation. Transmission line equations are developed from both Maxwell's and Kirchoff's equations. Both AC steady state and time domain solutions to transmission line equations are given. Time domain solutions bring out the traveling wave concept and the position-time diagram technique. AC steady state solutions introduce two-port network parameters and standing waves, VSWR and the Smith Chart.

Chapter 4, on scattering (S) parameters, emphasizes that S-parameters are the only convenient way of measuring transmission line parameters above approximately 30 MHz. The scattering matrix is defined with examples of two-port networks characterized by S-parameters. In Chapter 4 and elsewhere, important measurement instruments such as the network analyzer and the time domain reflectometer are described in detail, providing a valuable relationship between important measurement instruments and transmission line theory.

Chapter 5 introduces non-TEM transmission lines. This chapter deals almost exclusively with the microstrip, with brief discussions of the slot line, helical line and parallel strip line. A quasi-static approximation to the microstrip is given and is followed by a short discussion of the frequency dependence of the microstrip line. This chapter is quite brief, with greater detail left to the references at the end of the chapter.

Chapters 6, 9 and 10 present valuable and analytic tools for transmission line calculations. Conformal transformations are introduced with several examples showing how conformal transformations can be used to solve transmission line configurations which may not be treatable by other techniques. Numerical analysis techniques are given for a discrete solution to Laplace's equation or Poisson's equation solved by the method of Green's functions. Several examples are given, including source code listings in standard FORTRAN IV. These examples are carefully selected so the reader may modify them to handle real problems.

Chapter 7 deals with losses in transmission lines, but considers only the skin effect (ohmic) losses in detail. The other major loss mechanisms, dielectric and radiation, do not, the author claims, lend themselves to detailed analysis.

In Chapter 8, coupled transmission line theory is presented using four-port impedance matrices. Of special interest in this chapter are bandpass and band stop coupled line filters. Coupled transmission line analysis is especially important because fields and propagation modes are being coupled, for which there is no direct parallel analysis using lumped element network theory.

The last two chapters deal with several practical applications of transmission lines, i.e., for impedance matching, dc blocks, attenuators and others. A discussion of balun transformers for impedance matching and unbalanced to balanced signal conversion emphasizes the advantages of balun transformers where, at high enough frequencies, ground plane impedance results in non-equipotential ground reference points.

Since the designer and EMC analyst must deal with ever increasing circuit operating frequencies, the transmission line properties of circuit connections must be considered. This book provides an excellent introduction and reference to modern transmission line theory and applications. The book is useful in extending EMC coupling models to higher frequencies where low frequency approximations are no longer valid. The book is well written, with occasional use of "word pictures" to facilitate a better understanding of transmission line effects. References are often referred to in the text, with a very helpful description of the contents of references at the end of each chapter. The book is recommended for the designer and EMC engineer interested in applying transmission line theory for analyzing and solving many EMC problems.

MEETINGS & EVENTS

1981 IEEE INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY

BOULDER, COLORADO - AUGUST 18-20, 1981

CALL FOR PAPERS

Year by year, EMC technology continues to advance on the problems created by the electronics revolution. We hope this year to see it "rising to greater heights" as it carries on the crusade for true compatibility among electronic systems. Authors are invited to submit original, unpublished papers in all areas of EMC theory and practice. Suggested topic categories include, but are not limited to, the following:

TECHNOLOGICAL AREAS	APPLICATION AREAS
Analysis	Aerospace
Control	Automation
Design	Bio-Medical
Hazards	Business Machines
Instrumentation	Communications
Lightning	Computers
Management	Consumer Products
Materials	Defense
Measurements	Energy
Medical	Production
Modelling	Remote Sensing
Standards	Transportation

Prospective authors should submit a 50 to 70 word abstract and a 500 to 700 word summary (up to five illustrations) that clearly explain their contribution, its originality, and its relevance to the EMC discipline. For anonymity during review, please identify author(s) only on the cover sheet. Upon acceptance, authors will receive forms and instructions for the preparation of materials to be printed in the Symposium Record. If poster presentation is desired, please indicate on the material submitted. Papers written by bonified students will be eligible for a student prize.

AUTHORS' SCHEDULE

Abstract and Summary (3 copies required)... Dec. 12, 1980

Notification of Acceptance . . . . . Jan. 16, 1981

Camera-ready copy . . . Mar. 13, 1981

Submit Abstracts and Summaries to:

Scott Bennett
Hewlett-Packard Co.
3404 E. Harmony Rd.
Ft. Collins, CO 80525
303-226-3800, Ext. 3161

For more information, contact:

Bud Taggart
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Div. 723.03
Boulder, CO 80303
303-497-3462

FOURTH ELECTROMAGNETIC COMPATIBILITY SYMPOSIUM AND TECHNICAL EXHIBITION

ZURICH, MARCH 10-12, 1981

After three successful international conferences in Montreux 1975 and 1977, as well as in Rotterdam 1979, each attended by approximately 500 participants from 27 countries and up to 23 exhibitors, the Fourth EMC Symposium and Technical Exhibition will be held from March 10 to 12, 1981, at the Federal Institute of Technology Zurich (ETHZ).

The conference is organized by the Institute for Communications Technology of the ETHZ under the auspices of Mr. F. Locher, Director-General of the Swiss PTT, and is sponsored by the Association of Swiss Electrotechnicians (SEV/ASE). Symposium President is Prof. Dr. P. Leuthold. Further members of the Organizing Committee are Dr. T. Dvorak (Organizing Chairman), Prof. Dr. F. L. Stumpers (Program Chairman) and others. A number of national and international professional organizations support the conference technically.

The technical program of the symposium features 112 papers, which will be delivered in three parallel daily sessions: "Spread Spectrum Compatibility," "Characterization of Interference and Noise and Evaluation of System Performance," "Intrasystem 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," "EMC Measurements 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." The conference language is English.

Three two-hour workshops on "EMC Diagnostics," "EMP Hardening of Electronic Systems," and "Applications of Programmable Calculators and Computers for EMI Prediction and EMC Design," organized by renowned experts, technical excursions and the usual social events, including a banquet at which best papers will be awarded monetary prizes, complete the program.

As usual, the symposium will review the current status and future trends of the EMC science. The workshops, organized on a question-answer basis in direct contact with the speakers, provide an introduction to newcomers, and respond to the needs of practicing engineers. The exhibition, which also will be open to the non-registered public, will introduce modern measuring techniques, new technologies in materials and components, as

well as EMC training programs. The full text of all conference papers will be made available in the conference proceedings" EMC 1981."

Copies of the Preliminary Program with registration forms and further information concerning the symposium and technical exhibition may be obtained from: Dr. T. Dvorak, ETH Zentrum-KT, 8092 Zurich, Switzerland; Phone: (+411) 326-2790; TLX: 53 178 eth bi.

URSI GENERAL ASSEMBLY TO CONVENE IN WASHINGTON, DC, IN AUGUST, 1981

The Twentieth General Assembly of the International Union of Radio Science (URSI) will be held in Washington, DC on August 10 to 19, 1981. Over 1000 scientists from all parts of the world are expected to attend.

General Assemblies of the Union are held every three years, traditionally alternating between European and non-European sites. The two previous URSI General Assemblies held in the United States were in Washington, DC in 1927 and in Boulder, CO in 1957. The most recent URSI General Assembly, held in Helsinki, Finland in August 1978, included five open symposia on specialized topics in addition to the technical sessions of the Commissions. Over 500 papers were presented in about 100 sessions. The technical program in Washington is expected to be of comparable size.

The Union is an international organization devoted to stimulating and coordinating studies in the electromagnetic and telecommunication sciences. It is one of the 18 international unions within the International Council of Scientific Unions (ICSU). URSI's members are 36 National Committees rather than individuals. The United States National Committee for URSI (USNC/URSI) represents the United States National Academy of Sciences within the Union. URSI realizes its aims largely through its nine Commissions which cover the following fields: electromagnetic metrology and biological effects of electromagnetic waves; fields and waves; signals and systems; physical electronics; electromagnetic noise and interference; wave phenomena in nonionizing media; ionospheric radio and propagation; radio waves in plasmas; and, radio astronomy. The General Assembly is the outstanding international event in the triennial program cycle of the Union and its Commissions. Other meetings sponsored by one or more Commissions are held between General Assemblies.

U. S. ACADEMY OF SCIENCES EXTENDS SUSPENSION OF MEETINGS WITH SOVIETS

The Council of the U. S. National Academy of Sciences voted on August 12th to extend its suspension of bilateral meetings, symposia, and workshops with the Soviet Academy of Sciences, while continuing exchanges of individual scientists. Last February, the Academy's Council voted to suspend all group activities with the Soviet Academy for a six-month period in response to its "deep concerns with recent events, in particular, actions by the Soviet government with respect to our Foreign Associate, Academician Andrei D. Sakharov."

The Council's statement said in part: "We remain deeply concerned by (Sakharov's) continuing exile ... Our suspension of those interacademy exchanges involving groups of scientists was a direct expression of this concern. This concern continues. The Council hopes that circumstances will so improve as to permit the resumption of these interacademy exchanges."

In announcing its decision to continue the suspension of interacademy group exchanges, the Council specifically exempted joint meetings on arms control and disarmament. It said that it would press for meetings of scientists of the two countries to discuss the technical aspects of this problem. The Council's statement also said: "Our present interacademy exchange agreement with the USSR expires on 31 December 1980. We have authorized our Foreign Secretary to begin discussions directed toward a new interacademy agreement more appropriate to scientific progress and with greater emphasis on multilateral arrangements."

THE SERVICE ECONOMY AN INTERNATIONAL TRADE WINNER

A bipartisan group of senators has introduced legislation to give a boost to the services industry sector of the economy by providing better information on its importance and by designating the Commerce Department as the lead agency on service industry issues. The principal sponsor, Sen. Daniel Inouye (D., Hawaii), said that services include widely divergent industries, ranging from technologically advanced industries such as data transmission to ordinary personal services such as cleaning. "Much of the resistance to the growth of a service-dominated economy has derived from the outmoded concept of services as being principally traditional labor-intensive industries rather than the modern high technology services such as communications, insurance, and banking," he said.

The absence of clear and comprehensive U. S. Government policies toward the service sector is seen and felt most acutely in the international trade area, Inouye noted.

The bill (S. 3003, July 31) was referred to the Governmental Affairs Committee.

NAVAIR EMC PROGRAMS

NAVAL AIR SYSTEMS COMMAND
ELECTROMAGNETIC ENVIRONMENTAL EFFECTS (E^3)
REQUIREMENTS AND CONTROL SYSTEM

The Naval Air Systems Command has established requirements to control electromagnetic environmental effects (E^3) on current and future weapon systems. The Naval Air Development Center, Warminster, PA, is developing an extensive data base (E^3 Requirements and Control System) to facilitate the implementation of E^3 requirements. The purpose of this data base is to assist the E^3 technical development and management of new weapon systems procurements and to assist operational forces in solving E^3 problems.

This data base will contain essential E^3 technical and management information needed to improve life-cycle effectiveness and survivability of major weapon systems. The Naval Air E^3 Requirements and Control System is part of a Navy-wide E^3 data base and will be the model for future Navy development and NAVMAT sponsorship.

The NAVAIRSYSCOM E^3 Requirements and Control System will utilize existing hardware and software to minimize costs. The Central Computer System at NADC using two CDC 6600's and two Cyber 175's is being considered as the central computer facility for the Naval Air E^3 Requirements and Control System. Computer facilities at other Navy agencies also will be utilized. The communication network presently is composed of existing WATS and AUTOVON lines, with plans to incorporate AUTODIN II when available.

The NAVAIRSYSCOM E^3 Requirements and Control System will consist of various files. The files proposed for the system are:

a. E^3 Control Program - Will contain funding, scheduling, and deliverables data for each NAVAIR active E^3 Control Program

b. Technology Assets - Will contain a list of technical contacts having expertise in a particular E^3 area

c. Electromagnetic Environment - Will contain EM environments for friendly, hostile, natural and electromagnetic pulse

d. Aircraft - Will contain a comprehensive list of equipments contained on Naval Aircraft

e. Aircraft Equipment Characteristics - Will contain EM characteristics of aircraft equipment

f. E^3 Problems - Will contain E^3 problems experienced during the system acquisition cycle including Fleet reported problems

g. ECPs - Will contain all E^3 ECPs for Naval aircraft weapons systems

h. Deviations/Waivers - Will contain all E^3 deviations/waivers for Naval aircraft weapons systems and equipments

i. EW Equipment - Will contain EM characteristics of EW equipment

j. Frequency Allocation - Will contain data for those systems with approved allocations, as well as the status (i.e., operational dates) and other pertinent technical specifications

k. Missile - Will contain EM characteristics of operational missiles and missiles under development

Initial implementation of four files will be completed by 30 September 1980. These files are the E^3 problems, ECPs, deviations/waivers and technology assets. Files to be added to the E^3 data base include:

a. Electromagnetic Environment
b. E^3 Control Programs
c. Frequency Allocation
d. Missiles

Files which will be reviewed for updating/revision are aircraft, aircraft equipment characteristics, and EW equipment.

NAVAL AIR SYSTEMS COMMAND
AIR SYSTEMS ELECTROMAGNETIC INTERFERENCE CORRECTIVE ACTION PROGRAM (ASEMICAP)

The Naval Air Systems Command (NAVAIRSYSCOM) has established the Air Systems Electromagnetic Interference Corrective Action Program (ASEMICAP) to stop the progressive deterioration of combat capability caused by rising Electromagnetic Environmental Effects (E^3) in F-14A, F-4J, A-7E, A-6E, EA-6B, E-2C, P-3C, S-3A, SH-3H, SH-2F and other air platforms. This program complies with DOD Directive 3222.3, Chief of Naval Operations (CNO) Executive Board Decision Memorandum ser 09/501285 of 16 June 1978 and NDCP Z0706-CC of 30 January 1979.

(Continued)

The Electromagnetic Environmental Effects (E^3) Class Evaluation project is a significant portion of this program which evaluates the adequacy of the Electromagnetic Environmental Effects (E^3) control design of various aircraft that are now in the fleet. The project will be accomplished by performing E^3 evaluations on selected aircraft. The evaluation results will be utilized to categorize problems, both new and old, existing on aircraft and will provide technical information to support Engineering Change Proposal (ECP) Action. In addition, the evaluation results will be analyzed to determine where state-of-the-art E^3 design techniques are deficient. These deficiencies will be reviewed and investigated by the Naval Air Development Center (NAVAIRDEVCEN/20P3) under the NAVAIRSYSCOM R&D program (Electromagnetic Compatibility Aerospace Research and Development/EMCARD). Resultant problems will be categorized in accordance with MIL-E-6051D. Problems will be investigated to the degree required, to provide substantial justification to allow submittal of an ECP. Inputs to the EMCARD Program will aid in establishing a higher level of Electromagnetic Compatibility for onboard Aircraft Systems in their operational environments and developing better design techniques for aircraft acquisition. The following EMCARD project tasks will be provided as appropriate with Class Evaluation Recommendations: Electromagnetic Environment Susceptibility Testing, Electromagnetic Filtering and Shielding, Transient Protection Devices, EME Effects on Multiplex Systems, Electromagnetic Pulse, Electronic Countermeasures Compatibility, and Emission Control. Class evaluations are being planned for the F-14A, A-7E, A-6E, P-3C, S-3A, E-2C, EA-6B, SH-3H, SH-2F, A-4M, F-18, CH-5B, CH-46, LAMPS MK III, EC-130, and AV-8B/C. Completion of the Class Evaluation project will have detected EMI deficiencies/EMI problems for each class/type of operational aircraft in the Naval Air Force inventory.

The F-14A class evaluation started in June 1980 and will be completed 30 October 1980. A class evaluation board will be convened after the completion of the tests to evaluate the E^3 problems found. The next aircraft scheduled for the class evaluation efforts is the A-4M which is tentatively scheduled for February, March and April 1981.

The above NAVAIR material was provided by Ron Lane, NADC, Warminster, PA.

NAVAL AIR SYSTEMS COMMAND FLEET OPERATIONAL ELECTROMAGNETIC INTERFERENCE (EMI) TELEPHONE "HOT LINE"

A Fleet operational Electromagnetic Interference (EMI) telephone "Hot Line" has been established to provide quick and ready assistance to the Fleet in reporting and resolving EMI problems as they are encountered. The Hot Line is available, therefore to all Fleet aviation personnel seeking informal, expert EMI technical assistance. As a beneficial spin-off, it also will assist in alerting NAVAIR Program Managers, and others, to the possible existence of more widespread EM problems than had been envisioned during the development and production process.

The Hot Line system will provide Fleet personnel with an easy method of reporting their EMI related problems, assist them in their self-help efforts, provide indirect training assistance, and supply Fleet EMI data for use by electronic engineers in comparison/analysis efforts. Nevertheless, use of Hot Line does not relieve activities of their responsibility for submitting EMI reports required by NAVAIR and OPNAV instructions, or for any other similar reporting requirements established elsewhere. The Hot Line is merely an informal accessory to those reporting requirements and is to be used primarily to gain immediate, real-time attention for EMI problems.

The Fleet Operational EMI Telephone "Hot Line" is now in operation. The commercial telephone number is 703-425-9666; efforts are now in progress to arrange for an AUTOVON number as well. The line is available 24 hours a day, seven days a week; however, at present, the line is manned only during working hours (0800-1700, EST). At all other times, the line will be answered by an automatic recording device and contact will be made with the caller no later than the first working day thereafter.

The Hot Line is manned and operated by a commercial firm (Electromagnetic Technology, Inc.) which is now under contract to provide this service. It is emphasized that the link is not secure; therefore, classified information will not be disseminated over this line. If the call is being recorded, callers are requested to provide their name, telephone number and a brief description of the problem. Upon receipt of a completed call, a "Hot Line Report Long Sheet" will be completed and immediately transmitted to the NAVAIRDEVCEN (Code 20P3) for follow-up action.

RADIO NOISE

by Tom Rubinstein
Associate Editor - Communications

Noise is one of the most important considerations in designing a land mobile radio system. It affects the system in many ways. A receiver's chassis sensitivity is essentially a noise specification. Environmental noise (both natural and man-made) can degrade a receiver's effective sensitivity by masking out desired signals. Transmitter noise from co-located stations (either land mobile or other services) can produce the same effect; but, frequently on a much greater scale.

We will briefly look at what a receiver sensitivity specification really means and then go on to discuss environmental noise and transmitter noise.

RECEIVER SENSITIVITY

A receiver's chassis sensitivity is limited by the noise produced in the receiver front end. Noise figure is the ratio (in dB) of the noise produced in a receiver front end to the thermal noise (kTB).

Since a receiver's chassis sensitivity is determined by the noise produced internally, it is obvious that the receiver's effective sensitivity may be degraded by being placed in a noisy RF environment. For example, if an antenna is connected to a receiver with a 12 dB Sinad sensitivity of 0.35 μV and the antenna receives random noise with a mean level of 1.0 μV, it is obvious that the receiver will not receive an incoming signal at 12 dB Sinad until the signal has substantially exceeded the 1.0 μV noise. In this case, the 12 dB Sinad chassis sensitivity of 0.35 μV would be degraded to an effective sensitivity of about 2 microvolts. It is, therefore, very important to consider noise in a system design.

ENVIRONMENTAL NOISE

As used here, the term "Environmental Noise" means any noise arriving at the receiver RF input terminal from any source except that emanating from a transmitter. Environmental noise has many sources, either natural or man-made. Natural noise sources include the following:

LIGHTNING DISCHARGE
GALACTIC NOISE
SOLAR NOISE

Man-made noise sources include, but are not limited to, the following:

VEHICLE IGNITION SYSTEMS
ELECTRIC MOTORS
CORONA DISCHARGES FROM POWER LINES

The RF level of interference from natural sources is insignificant at land mobile frequencies. Man-made noise is, however, quite significant. A number of workers have studied man-made noise in urban, suburban, and rural environments.[1] Their general conclusion is shown in Figure 1 of Reference 1. From this figure, we derived a formula for urban man-made noise relative to kTB. Making the assumption that the receiver has a bandwidth of 16 kHz, we arrived at the following formula for the absolute level of man-made noise:

$$Nu = 23.2 \log f - 75.7$$

Where Nu = Urban Noise Power (dBw)

f = Frequency (MHz)

Note: Nu may not be more negative than kTB (-161.9 dBw).

The same workers discussed above determined that the average noise powers in suburban and rural environments are typically 16 and 31 dB less (respectively) than in urban environments.

How does this affect system design? Referring to Table I (which was derived from the above formula), assume that you are trying to calculate the mobile range in an urban area on high band. Can you assume full receiver sensitivity (typically - 146.1 dBw for 12 dB Sinad)? Not when you have an average noise level of -126.2 dBw! A more realistic sensitivity assumption would be about 6 dB stronger than the noise (-120.2 dBw).

What does this say about manufacturers' sensitivity specifications? First, it says that those low band mobiles with 0.25 microvolt (-149 dBw) Sinad sensitivity are a big overkill. You can't use that much sensitivity, even in a rural environment. It says something practical, too. When evaluating two radios, do not be overly impressed by more sensitivity if, in your environment, both of the specified sensitivities are already below the level of the environmental noise. An area where sensitivity specifications could be improved and really improve system performance is in the 800 MHz band. Noise levels in 800 MHz are sufficiently low to permit a substantial improvement to be made in range by increased receiver sensitivity.

TRANSMITTER NOISE

Transmitter noise is normally produced in the first stages of an exciter. Because of frequency multiplications, a small amount of frequency deviation in an early stage will be multiplied by the same factor as the frequency. One design approach which has helped to reduce the magnitude of transmitter sideband noise is the use of direct FM (versus phase modulation). The direct FM technique, incorporated by several of the two-way manufacturers, substantially reduces transmitter sideband noise.

The only major area where transmitter sideband noise is of great concern is in designing radio sites. A radio site design must account for transmitters emitting noise on frequencies other than the assigned channel.

To determine whether a potential transmitter noise problem exists, the system designer first determines T - R freqeuncy spacings. He then refers to transmitter noise curves (published by the radio manufacturer) to determine how much noise will be emitted on the various receiver frequencies. This level of noise is reduced by the amount of decoupling between the transmitting and receiving antennas, if applicable, or by decoupling resulting from duplexer. If a potential for interference exists, two major remedies are possible. Antenna spacing may be increased to reduce coupling between the transmitting and receiving antennas. Cavity filters may be placed in the transmitter output line to reduce the amount of off-channel noise. No amount of filtering in the receiver antenna line will help reduce the effects of on-channel noise.

CONCLUSION

We have seen that radio noise can substantially affect the performance of a radio system. Moreover, any receiver whose chassis sensitivity is better than the prevailing noise level will have the same effective sensitivity as any other receiver whose chassis sensitivity is better than the prevailing noise level, regardless of their relative chassis sensitivities.

In contrast to environmental noise, transmitter noise is controllable. Techniques exist for reducing transmitter to tolerable levels; whereas with environmental noise we just have to live with it.

The key statement is: Watch out for noise. It'll sneak up on you and degrade your system.

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[1] "Radio Noise and Interference," Reference Data for Radio Engineers, 6th Edition, 1975, Howard W. Sams Co., pp. 29-1 thru 29-6.

(Reprinted from the August 1980 issue of the IEEE Vehicular Technology Society Newsletter.)

ELECTRONIC CANCER TREATMENT

Medical institutions around the country are using microprocessor-controlled microwave devices in experiments they hope will lead to the successful treatment of cancer without the painful experience of chemotherapy. The method of treatment, called "hyperthermia," involves heating a cancerous tumor with microwaves, thereby providing an unsuitable climate for the tumor. The computerized portion of the device provides safeguards against damage to surrounding healthy tissue.

The technique was first developed at the Stehlin Foundation for Cancer Research in Texas in the early 70s by Dr. John S. Stehlin and Dr. Beppino C. Giovanella, who discovered that 41° to 43°C is a critical temperature at which tumor cells can be killed, leaving normal cells alive. Experiments also are being conducted at the University of Rochester, Stanford University and the Memorial Sloan-Kettering Cancer Center.

The technique depends on the fact that, compared to healthy tissue, cancer tumors have a relatively restricted blood flow and accumulate more liquid. Because of this, the tumor normally contains more heat than does healthy tissue, and will reach a higher temperature when subjected to microwaves. The microwave device used at the Stehlin Foundation was developed by the Johnson Space Center and manufactured by Lockheed Electronics. The microprocessor was made by Motorola. The components are all off-the-shelf and are manufactured in the U.S. to cut down on lead times when replacements are needed.

The device, which emits energy through two electrodes placed on either side of the body where the cancer is located, is capable of generating up to 1 kW at frequencies between 10 kHz and 200 MHz, as compared to conventional diathermy devices, which operate at 2450 MHz. The operating range of the machine, though, is restricted to between 3 to 30 MHz, with up to 400 W of power.

A problem with the microwave treatment has been the burning of skin immediately below the electrodes. Dr. Kumar Krishen, who heads the NASA team from the Experiment Systems Div. of the Johnson Space Center, found that circulating temperature-controlled water through metal tubing soldered on the back of the electrodes cools the skin. "Burns are no longer a concern," says Dr. Krishen.

The computerized elements not only guard against burning healthy tissue but, also control certain functions of the device. Two probes are inserted into the normal tissue surrounding the tumor and provide feedback to the system, regulating the temperature and duration of treatment. The probes will automatically shut down the device if normal tissue temperature exceeds 43°C, if excessive ground leakage current exists, or if the microwave power exceeds 400 W, considered the uppermost limit of safety for humans.

In addition, the probes provide feedback that enables the device to be tuned to the body's resonance. The machine will not operate if a system mismatch is present. The device also automatically shuts down every half-minute for three seconds of full analysis, the results of which are printed on a line printer.

"We're not ready to report all the results yet," says Dr. Stehlin," but there is a lot of hope for this method of treatment. The signs are good, and the patients are responding well."

Dr. Krishen says, "As the system becomes more sophisticated and we learn the limits of the computerized feedback system, we'll be able to fine-tune the microwave frequencies to specific types of cancers."

DR. YOUNG RESPONDS TO REPORT OF PRESIDENTIAL COMMISSION ON PENSIONS

Dr. Leo Young, President of the IEEE, has proposed four major recommendations to the President's Commission on Pension Policy on the issues of vesting, retirement accounts, survivor benefits, and age discrimination. Commenting on the Interim Report of the President's Commission released in May, Dr. Young based his recommendations on the fact that "a majority of Americans are not vested in a pension, while the minority who are vested are frequently vested in a poor or deficient plan and often don't even know it. Inequities, capricious variations, and deceptive packaging are all too common."

He urged the Commission to recommend one-year full vesting. By reducing the time period for full vesting, the burden placed on highly mobile employees such as engineers would be alleviated. In addition, it would alleviate the problems accompanying the practice of firing an employee who might have worked for 9 years and 11 months for a firm whose vesting requirement is 10 years. In his column for the August issue of The Institute, the IEEE monthly newspaper, Dr. Young also urged the Commission to endorse the LERA concept. LERA (Limited Employee Retirement Account) would permit an employee who is not vested or who is covered by a poor employer pension plan to contribute to an Individual Retirement Account plan of his own. Present tax laws prohibit such contributions.

He also recommended that the protection of the law be extended to the spouses and children of employees. Presently, those survivors frequently lose their benefits if the employee leaves his job or dies before retirement age. Dr. Young's fourth recommendation was the elimination of age discrimination. Social Security payments to older workers should not be reduced or taxed, if those workers are able to supplement their Social Security payments.

The IEEE, with over 200,000 members world-wide and 170,000 U. S. members, has been active in attempts to modify present tax laws to improve pension systems in the United States and improve pension benefits for its membership. Individuals who have chosen a highly mobile profession are penalized under the inequitable pension structure which exists in America today.

TWELVE AT NBS SHARE INVENTION AWARDS

Twelve researchers at the Commerce Department's National Bureau of Standards (NBS) have won six awards in the 1980 round of the prestigious I-R 100 Awards. Sponsored annually by Industrial Research/Development magazine, the I-R 100s are awarded to the 100 inventions - selected from thousands of entries - judged to be the most significant new technical products of the preceding year. The awards were announced at ceremonies on September 18th in Chicago.

The NBS award winners whose project is most closely related to the EMCS are Lanny Driver and Francis X. Ries.

Driver and Ries of the NBS Center for Electronics and Electrical Engineering received their I-R 100 Award for the development of an improved instrument for measuring the voltage of radio-frequency (RF) signals in 50 ohm coaxial systems over an exceptionally broad range of voltages and frequencies.

Called an RF Voltage Comparator, it uses a closely-matched pair of Schottky-barrier detecting diodes which compare the unknown RF voltage to some reference source of AC voltage. The detected voltages are algebraically summed to give a DC voltage proportional to the difference between the two. The AC voltage is adjusted until this DC voltage is reduced to a null value, at which point the AC reference voltage equals the RF voltage.

The instrument has a frequency range of from less than 100 kHz to greater than 1 GHz, and currently has a voltage range between 10 mV (rms) and 20 V (rms). These ranges, according to Driver and Ries, are limited primarily by the semiconductor diodes, and could be increased by improvements in diode technology.

The voltage comparator can be used to calibrate a number of radio-frequency products including voltmeters, power meters, signal generators, and attenuators. In addition, it can be used as a highly precise voltmeter or as a continuous monitor of critical radio-frequency voltages whose stability might be affected by time, ambient variations, and powerline fluctuations. It is unmatched by any other precision RF voltage measurement system in terms of frequency and dynamic range and simplicity of operation.

NOMINATIONS FOR IEEE FELLOWS

It is again time to make preparations for nominating outstanding individuals for advancement to the grade of Fellow. The purpose of this article is to remind all members of the EMC Society to consider possible Fellow candidates. In particular, Chapter Chairmen and other Chapter officers, and Fellows, by virtue of their knowledge of activities and capabilities of Chapter members, have a responsibility for Fellow nominations. The word "responsibility" is used because, in fact, these persons should make very sure that no deserving individual is overlooked. Although Jim Hill, the EMC Society Awards Chairman, and the members of the Awards Committee, through personal knowledge and contacts in the EMC society, attempt to review all possible candidates, there is always the possibility that outstanding performances may not be recognized. So - each of you is urged, requested and asked to search out those individuals with outstanding records who may be candidates for Fellow nomination.

What are the ground rules? First, and very important, anyone, regardless of IEEE grade, can be a nominator. Second (and this is the rule which causes more confusion than any other), the nominee must have been a member of IEEE, in any grade, for at least five years prior to nomination, and must be a Senior Member at the time of nomination. Note that he does not have to be a Senior Member for any prescribed period of time! Third, five references are required. All references must be Fellows. Nominators cannot also act as references. It is generally prudent to have seven to ten references in case some references fail to reply in time or mail gets held up. Fourth, endorsements by a Section and a Chapter, although not required, are highly desirable. Fifth, each nominee must be evaluated by an IEEE Society. This Society to do the evaluation is normally one recommended by the nominator. All nominees evaluated by a Society must be listed in rank order. In the EMC Society, this evaluation is performed by the EMC Society Fellow Evaluating Committee consisting of three Fellows - Ed Chapin (formerly with the Federal Communications Commission), Mike Lustgarten (of the DoD Electromagnetic Compatibility Analysis Center at Annapolis), and the undersigned. The members of the Evaluating Committee call upon many other Fellows for assistance in the evaluation process.

All nominating papers, information from Fellow references, Society evaluations, and Section and Chapter endorsements eventually end up with the 17 member IEEE Fellow Committee which recommends the final list of selections to the IEEE Board of Directors for confirmation. Generally, there are about 300 nominations each year of which about 125 are approved by the Fellow Committee for final action. The IEEE By-laws limit the number of new Fellows each year to .6 of 1% of the number of Senior Members and .1 of 1% of the total IEEE membership, exclusive of Student Members.

All material (with the exception of Society evaluations) must be received by the IEEE Fellow Committee by April 30. The Society evaluations must be received by the IEEE Fellow Committee by June 15. But - don't let these dates fool you! Completing all of the paperwork, contacting references, getting references to respond and getting the endorsements takes time, sometimes several months. Every year, we have one or more nominations that don't make it to final consideration by the IEEE Fellow Committee because of some sort of problem that can't be resolved because the paperwork started too late or got held up somewhere in the process. Our recommendation - get the paperwork started NOW (several nominations are already in progress).

Results of nominations received in the spring of 1981 will be announced in December 1981 and will be published in a subsequent issue of SPECTRUM.

The details of Fellow nominating procedures are contained in the IEEE Guide for Fellow Grade Nominations (IEEE Publication FG-1) which is revised each year. Nominating kits containing FG-1 and all necessary material and forms can be obtained from the undersigned, from Jim Hill, or by writing directly to the IEEE Fellow Committee, Staff Secretary, 345 E. 47th St., New York, NY 10017; Tel.: 212-644-7750.

Again, please cooperate. Don't let deserving individuals get left out because of indifference or neglect. For additional information, contact me at 301-881-4036 or write 7121 Wolftree La., Rockville, MD 20852.

EMCABS

EDWIN (ED) BRONAUGH

EMCABS

In this issue we are publishing 36 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. Several members of our present committee have indicated they cannot continue to support EMCABS work, so I am now looking for volunteers to help abstract EMC articles. Please write to me at the address listed in the listing of associate editors.

L. F. Babcock	E. L. Bronaugh
J. S. Hill	R. N. Hokkanen
J. R. Janoski	M. Kant
D. R. Kerns	G. R. Redinbo
R. B. Schulz	R. M. Showers

HOW TRANSPARENT STATIC SHIELDING BAGS IMPROVE OPERATIONS AT HONEYWELL PLANT

ACCESSION NO. EMCABS 9-80-1

Phillip Kohlhaas
3M Company

INSULATION/CIRCUITS
Vol. 25, No. 2, February 1979, pp. 21-22

ABSTRACT:
The transparent bags protect static-sensitive electronic components by creating a "Faraday cage" around them. The bags consist of a conductive nickel outer layer which provides electrostatic shielding, a polyester film layer for high tensile strength and tear resistance, and a heat-sealable, anti-static polyethylene inner layer that resists static charging caused by friction of parts moving in the bag.

INDEX TERMS:
Static charge, handling, storage bags, conductive plastic, IC protection

ANTISTATIC EQUIPMENT AND TECHNIQUES

ACCESSION NO. EMCABS 9-80-2

Dallas Erickson, Associate Editor

ELECTRONIC PACKAGING AND PRODUCTION
Vol. 19, No. 2, February 1979, pp. 74-96

ABSTRACT:
Component damage due to static electricity has forced the industry to take a second look at this once trivial problem. These losses can be cut to near zero with presently available antistatic equipment.

INDEX TERMS: Static Electricity, Microcircuits, Static Meter, Conductive Bags, Packaging, Work Stations, Air Neutralization

OPTIMIZE RIPPLE/EMI PERFORMANCE IN SWITCHING-REGULATOR DESIGNS

ACCESSION NO. EMCABS 9-80-3

Laird L. Macomber
Cornell-Dubilier Electronics

EDN
Vol. 24, No. 1, January 5, 1979, pp. 123-129

ABSTRACT:
Low-ESR/ESL aluminum electrolytics can improve supply operation; the key lies in understanding their high-frequency characteristics.

INDEX TERMS: Electrolytic Capacitor, Capacitor Series Resistance, Capacitor Series Inductance, Frequency effects

ARC-SPRAY GUN APPLIES ZINC FOR EMI/RFI SHIELDING

ACCESSION NO. EMCABS 9-80-4

ELECTRONIC DESIGN
Vol. 27, No. 3, February 1, 1979

ABSTRACT:
Easily and inexpensively, an arc metalizing gun can apply a thin zinc coating that can achieve 60-to-90-dB shielding attenuation over 1 to 1000 MHz with thin--0.003-to-0.005-in.--coatings directly on the most heat-sensitive plastics, whether solid or foam.

INDEX TERMS: Flame Spray Coatings, Shielding Plastics, Arc Spray Gun

PROPER HANDLING OF VOLTAGE SPIKES SAFEGUARDS CIRCUIT DESIGN

ACCESSION NO. EMCABS 9-80-5

Laudie Doubrava
Tektronix Inc.

EDN
Vol. 24, No. 5, March 5, 1979, pp. 83-87

ABSTRACT:
Correctly applied, bypassing beats decoupling as a means of coping with noise generated by real-world parasitic inductance.

INDEX TERMS: Transients, Voltage Spikes, Inductance, Suppression Bypass Capacitor

TRANSIENT SUPPRESSORS

ACCESSION NO. EMCABS 9-80-6

Alex Mendelsohn, Associate Editor

Electronic Products
Vol. 21, No. 10, March 1979, pp. 31-40

ABSTRACT:
A transient is a brief pulse that can wreak havoc in milliseconds. Transients often cause slow degradation, erratic operation or catastrophic failure in semiconductors, insulation dielectrics and switch and relay contacts. Protection involves choosing a method of dissipating the energy at a level sufficiently low to avoid damage to sensitive components and circuits.

INDEX TERMS: Lightning, EMP, Transients, Suppression, Zeners, Varistors, Spark Gaps, Filters, RC Networks, Isolation

SPECTRUM ANALYSIS - PART ONE DEFINITIONS, DESCRIPTIONS AND APPLICATIONS

ACCESSION NO. EMCABS 9-80-7

"Spectrum Analysis - Theory, Implementation and Applications" Published by Rockland Systems Corp.
Electronics Test
Vol. 2, No.6, June 1979, pp. 34-38

ABSTRACT:
This article (Part One) describes what spectrum analysis is, how spectrum analyzers function and some major applications for the instruments. A description of spectrum analyzers available today and their manufacturers will appear in the August issue.

INDEX TERMS: Spectrum Analysis, Fourier Transform, Time-Domain

EASY-TO-MAKE ALUMINUM PARTICLES PROMISE LOW-COST EMI SHIELDING

ACCESSION NO. EMCABS 9-80-8

David Stutz
Battelle Institute, Columbus, Ohio
Electronic Design
Vol. 27, 29 March 1979, pp. 51-52

ABSTRACT:
Plastic compounds filled with aluminum fibers and flakes could be a much more economical way to shield an instrument from electromagnetic interference than solid steel or aluminum housings. Aluminum particles are not only simple and inexpensive to manufacture, they are good thermal and electrical conductors as well.

INDEX TERMS: Shielding, Conductive Plastic, RF Attenuation

AN EMI SHIELD IS ONLY AS EFFECTIVE AS ITS WEAKEST LINK--THE GASKET

ACCESSION NO. EMCABS 9-80-9

Bert Rashkow
Metex Corp.
Electronic Design
Vol. 27, 26 April 1979, pp. 88-94.

ABSTRACT:
With the proper shielding material--one with good conductivity and high permeability--and with enough thickness, you theoretically can attain almost any level of attenuation of undesired noise and signals. But to provide physical access to the space inside the shielded region, you need openings--which need gaskets to seal covers for the opening. Poorly designed gasket systems can limit EMI shielding severely.

INDEX TERMS: Conductive Gaskets, Shield Joints, Corrosion, Resilience, Compression, Unevenness, Gasket Types

MANIPULATING IMPEDANCE PROTECTS RELAY ...

ACCESSION NO. EMCABS 9-80-10

Brian J. Hogan, Midwest Editor
Design News
Vol. 35, No. 8, 4/23/79, Pp. 134-135

ABSTRACT:
A process alarm relay is made resistant to radio frequency interference (RFI) by forcing interference to enter the device through high-impedance paths. It then provides low-impedance paths to remove any RFI that leaks into it.

INDEX TERMS: Relays, Suppression, RFI, Filters

INDUCTIVELY LOADED SSRs CONTROL TURN-ON TO ELIMINATE FIRST-CYCLE CURRENT SURGES

ACCESSION NO. EMCABS 9-80-11

John Beigel Product Manager
Electronic Instrument & Specialty Corp.
ELECTRONIC DESIGN 6
Vol. 27, No. 6, 15 March 1979, pp. 90-93

ABSTRACT:
Although advantageous for resistive lamp loads, zero-voltage turn-on is the worst possible way to activate a highly inductive load, since it then produces maximum current surge. Therefore, some SSR manufacturers suggest the use of random turn-on relays for inductive loads, so that the worst condition--zero-voltage turn-on-- occurs only occasionally.

Unfortunately, some other manufacturers wrongfully imply that zero-voltage turn-on is the solution for all current-surge problems.

INDEX TERMS: Inductive Loads, Solid State Relays, Switching, Zero Voltage Crossover, Current Surges

THE CONNING OF AMERICA

ACCESSION NO. EMCABS 9-80-12

John M. Osepchuk
MICROWAVE JOURNAL
Vol. 21, No. 10, October 1978, Pages 18-72

ABSTRACT:
You're probably aware of recent publicity about "microwave radiation hazards", stimulated by Paul Brodeur's book, The Zapping of America. By default, the public is led to believe that microwaves pose unknown, possibly high downside risks with little upside gain, since the general public knows little of microwaves beyond microwave cooking.

INDEX TERMS: Biological, Microwave Radiation, RADHAZ, Safety

THE NEXT GENERATION RF SPECTRUM ANALYZER

Steven N. Holdaway and M. Dee Humpherys

ACCESSION NO. EMCABS 9-80-13

Hewlett-Packard Journal
June 1978, pp. 2-8.

ABSTRACT:
Unprecedented tuning accuracy, frequency stability, and resolution - combined with a new level of control provided by three digital processors - raise to significantly new levels the art and science of spectrum analysis in the 100-Hz-to-1500-MHz range.

INDEX TERMS: Spectrum Analyzer

EMI CAN BE LICKED

Dave Howell, Associate Editor

ACCESSION NO. EMCABS 9-80-14

ELECTRONIC PRODUCTS
Vol. 20, No. 10, March 1978, pp. 45-52

ABSTRACT:
A multitude of materials arm the equipment designer in his battle against electromagnetic interference. Here's a look at some of the products available and tips on how, where and when to use them.

INDEX TERMS: Shielding, Air Vents, Windows, Gaskets, Conductive Elastomers, Spring Fingers, Conductive Plastics, Manufacturers

REDUCING ELECTROSTATIC DAMAGE USING PROTECTIVE MEASURES
Dr. James R. Huntsman
3M Company, St. Paul, MN

ACCESSION NO. EMCABS 9-80-15

DIGITAL DESIGN
Vol. 8, No. 10, October 1978, pp. 22-24

ABSTRACT:
Electrostatic damage is a major cause of device failure. No one purposely places 5 kV to 10 kV across a PC board or any kind of IC. Yet, time and again, inadequate and careless handling and packaging precautions subject boards and circuits to degrading and even destructive voltages.

INDEX TERMS: Static Electricity, Microcircuits, Conductive Bags, Floor Mats, Ionized Air

ADVANCED WAVEFORM RECORDERS DO MORE THAN CAPTURE TRANSIENTS
Don Dedinas
Biomation Div., Gould Inc.

ACCESSION NO. EMCABS 9-80-16

EDN
Vol. 23, No. 16, September 1978, pp. 103-110

ABSTRACT:
Don't overlook waveform recorders. With them you can capture transient or repetitive signals and automate data acquisition and analysis.

INDEX TERMS: Waveform Recorders, Transients

PACKAGING CRT DISPLAYS IN NEAR-FIELD ENVIRONMENTS
Richard D. Vance and William F. Griffith
Ad-Vance Magnetics, Inc., Rochester, Ind.

ACCESSION NO. EMCABS 9-80-17

ELECTRONIC PACKAGING & PRODUCTION
Vol. 18, No. 10, October 1978, pages 125-132

ABSTRACT:

The neck of a CRT is vulnerable to EMI. Concentric shields require the allotment of adequate volume.

INDEX TERMS: Susceptibility, Magnetic Field, CRT's, Displays, Magnetic Shields

EMI/RFI FILTERS, ONE ANSWER TO ELECTRICAL POLLUTION
Gary Elinoff, Associate Editor

ACCESSION NO. EMCABS 9-80-18

ELECTRONIC PRODUCTS MAGAZINE
Vol. 21, No. 5, October 1978, Pages 35-40

ABSTRACT:

If you need a filter, you'll find it fairly simple to learn how the various types work, and what sort of capabilities you can expect from each. As far as standards are concerned, though, it's a different matter.

INDEX TERMS: Filters, Suppression, Standards, Power Lines

DYNAMIC NON-LINEARITY MEASUREMENT IN FM SYSTEMS

ACCESSION NO. EMCABS 9-80-19

Jerome Cohen
RHG Electronics Laboratory, Inc., Deer Park, N.Y.
MICROWAVE JOURNAL
Vol. 20, No. 9, September 1977, pages 63-64

ABSTRACT: Intermodulation noise in the demodulated baseband lessens the effectiveness of FM radio links. This paper outlines a procedure for evaluating the intermodulation noise contributions arising from non-linearities in both components and subsystems.

INDEX TERMS: FM, Intermodulation, Measurement, Non-linearity, Harmonic Suppression

HOW TO KEEP COMPUTER LINES "CLEAN"

ACCESSION NO. EMCABS 9-80-20

Ruxton Tucker
Sola Electric, Elk Grove Village, Ill.
INSTRUMENTS & CONTROL SYSTEMS
Vol. 50, No. 7, July 1977, pages 39-40

ABSTRACT: Power line fluctuations play havoc with computer operation. A simple "clean-up" is a voltage regulator.

INDEX TERMS: Computers, voltage regulator, susceptibility, power line fluctuations

HOW TO AVOID NOISE PICKUP ON WIRE AND CABLE USING TWISTED AND/OR SHIELDED WIRE AND CABLE,...

ACCESSION NO. EMCABS 9-80-21

Bruce E. Klipec
Samuel Moore and Co.
INSTRUMENTS & CONTROL SYSTEMS
Vol. 50, No. 2, December 1977, pages 27-30

ABSTRACT: With more sophisticated and sensitive instruments than in the past, the reduction of electrical noise pickup by instrument and control circuits has become a serious problem.

INDEX TERMS: Sensitive circuits, twisted wire, shielded cables, grounding, magnetic fields, common mode noise,

EMC Analysis Capabilities for Programmable Calculators - HP 67/97

ACCESSION NO. EMCABS 9-80-22

Richard Larson and M. A. Skeath
Electromagnetic Compatibility Analysis Center, Annapolis, MD
Aug 78, 14 magnetic cards ECAC/PD-75/004 Hewlett Packard HP 67/97 magnetic cards PB-283 025/5GA Mag Cards $375.00

ABSTRACT: 14 calculator programs pertaining to electromagnetic compatibility analysis are contained in thispackage. The programs are designed for operation on the HP67 and HP97 calculators. The package includes such programs as Path Loss (1-10,000 MHz), Off-Frequency Rejection, Great Circle Geometry (Distance/Bearing), Coordinate Conversions (UTM - Lat/Long - UTM), Frequency Analysis (Intermod, Harmonic), Radar Emission Spectra, Terrain Profile Analysis. Each program is stored on HP 67/97 magnetic cards. Documentation on each program includes applications, analysis, logic flow diagrams, operating instructions, and sample calculations.

INDEX TERMS: Software, electromagnetic compatibility, magnetic cards, transmission loss, rejection, electromagnetic interference, computerized simulation, computer systems programs.

Prototype HEMP Design Practice Handbook
Extended outline 25 Apr 77-31 May 78.

ACCESSION NO. EMCABS 9-80-23

Lloyd Duncan
IRT Corp San Diego Calif
31 May 78, 192 p IRT-8165-012, AD-E100063 AD-A056 731/3GA PC A09/MF A01 Contract DCS100-77-C0040

ABSTRACT: The Prototype HEMP Design Practice Handbook provides a systematic approach to protection of the DCS. The handbook is based on a generalized protection procedure which parallels the programed development cycle of systems. This protection procedure employs the zonal characterization of facilities and utilizes nested shields, regional grounding, penetration and aperture treatments in the form of design practices as the primary protection measure. The handbook is separated into two parts. Part 1 contains introductory material, the protection procedure and use of the protection elements. Part 2 contains appendicies of detailed resources.

INDEX TERMS: Radiation shielding, electromagnetic pulses, nuclear explosions, transient radiation effects, high altitude, electromagnetic radiation, radiation protection, protective equipment, electrical grounding, quality assurance, allocations, selection, validation, communication and radio systems, radio frequency cables, electric cables, handbooks.

Passenger Motor Vehicle Electrical System Integrity

ACCESSION NO. EMCABS 9-80-24

Jack Crenca, Kim Uhl, Howard Turnage, and Paul Bernazani
Atlantic Reserach Corp., Alexandria, VA
PB-301 062/6GA PC A10/MF A01 Contract DOT-HS-7-01777
Nov 78, 221 p DOT-HS-803 995

ABSTRACT: The report details the results of a two part study to examine the integrity of automotive electrical equipment and to determine the electromagnetic susceptibility of automotive electronic systems. The design and failure modes for various electrical components and recommended corrective measures are discussed in the first half of the Report. The second half deals with the potential susceptibility of electronic control systems to electromagnetic radiation and the results of a measurements program designed to determine the extent of the susceptibility of three existing systems to the electromagnetic environment. This half of the Report emphasizes the need for EMC standards and discusses various measurement techniques and means for setting limits in order to establish standards.

INDEX TERMS: Passenger vehicles, electric equipment, electronic control, electromagnetic compatibility, control equipment, ignition systems, radiofrequency interference, reliability (electronics), failure.

TV Channel 6 from Educational FM Signals
Lawrence C. Middlekamp, Hector Davis, Carl R. Weber, and Daniel J. Stanks
Federal Communications Commission, Washington, DC, Lab Div.
Sept 79, 20 p FCC/OST/LAB-79/01 PB-301 431/3GA PC A02/MF A01

ACCESSION NO. EMCABS 9-80-25

ABSTRACT: Tests were made of 45 television receivers to measure their susceptibility to interference from signals emitted by one or two educational FC radio stations. The data obtained from those tests infer that there has not been a marked imporvement in television receiver immunity at Channel 6 from Educational FM stations since 1952. Copies of R6702 'Calculations for Educational FM Assignments in Areas Served by TV Channel 6' are available from National Technical Information Service, Springfield, Virginia 22161. The accession number is PB-234 510. Data used in this report date to 1952.

INDEX TERMS: Television receivers, radiofrequency interference, frequency allocations, very high frequencies, radio broadcasting, frequency modulation.

Storm Research
Roy T. Arnold
Mississippi Univ., University Dept. of Physics
Final Rept. 1 Mar-30 June 78, June 79, 24 p NOAA-79080802
Grant NOAA-04-78-B01-9 PB-300 299/5GA PC A02/MF A01

ACCESSION NO. EMCABS 9-80-26

ABSTRACT: This report presents some lightning observations made from a mobile laboratory jointly equipped with support by NSSL, UM and ONR. The pertinent findings of the work are summarized below: (1) Electrical measurements were made on severe storms with the mobile laboratory; (2) A portable TV monitor was used successfully to document lightning flashes and some cloud features; (3) Cloud-to-ground (CG) lightning flash electric field change records were obtained for both positive and negative flashes; (4) Very short duration, bright, multiply branched CG flashes ('staccato' flashes) have been reported to occur near the radar weak echo region of severe storms 'near' the time that either tornadoes or changing wall cloud features are observed; (5) 3 MHz spherics data were recorded during the mature stage of several storms, but the data have been reduced.

INDEX TERMS: Lightning, thunderstorms, atmospheric electricity, electric fields television reconnaissance, electrical measurement.

The Infinite Parallel-Wire Array over a Ground Plane: A Code for an EMP Vulnerability Assessment and Hardening Program
Michael J. Vrabel
Harry Diamond Labs Adelphi MD
Technical memo Jul 79, 19 p Rept. no. HDL-TM-79-19 AD-A073 103/4GA PC A02/MF A01

ACCESSION NO. EMCABS 9-80-27

ABSTRACT: Elements of the multiwire parallel array over a ground plane are addressed with a systems-related EMP vulnerability assessment and hardening orientation. An abbreviated computer program supported by experimental data permits a claculation of the degree of interaction of the wires of a parallel array, the individual wire and array impedance to ground, and the relative current distribution among the wires exclusive of wire end loading. This represents the foundation for an inclusive EMP code. (Author)

INDEX TERMS: Computer program reliability, radiation shielding, coaxial cables, electromagnetic pulses, vulnerability, electromagnetic shielding, machine

4. Transients and Enclosures
Bureau of Mines, Washington, DC
Info. circular, 1979, 1979 p BUMINES/IC 8802 See also Part 3, PB-299 619. Also available in set of 4 rpts. PC E10 PB-299 616-SET.

ACCESSION NO. EMCABS 9-80-28

ABSTRACT: The report concerns two subjects important in the application of electric power in mining systems. Electrical transients and their suppression are discussed and several considerations are explored with regard to the use of explosion-proof or other electrical enclosures.

INDEX TERMS: Electric power distribution, mines (excavations), coal mines, surges, electrical faults, enclosures, electric equipment, explosion proofing, suppressors.

Mine Power Systems Research (In Four Parts)
2. Grounding Research
Bureau of Mines, Washington, DC
Info. circular, 1979, 1979, 84 p BUMINES/IC-8880 See also Part 1, PB-299 617 and Part 3, PB-299 619 PB-299 618-9GA PC A05.MF A01
Also available in set of 4 rpts. PC E10, PB-299 616-SET

ACCESSION NO. EMCABS 9-80-29

ABSTRACT: The publication contains five papers pertaining to the effective grounding of mine power systems, as follows: Ground-check monitor types and safety characteristics; ground wire monitors for surface coal mines; ground bed design and measurement; electrical ground rod corrosion; and a continuous ground bed resistance monitor.

INDEX TERMS: Electric power distribution, mines (excavations), electrical grounding, coal mines, monitors, safety, electrodes, corrosion.

Protection Military Personnel and the Public from the Hazards of Electromagnetic Radiation from Military Communications and Radar Systems.
Army Command and General Staff Coll Fort Leavenworth Ks
Final Report. Stephen A. Aliva 8 Jun 79, 126 p Master's thesis. AD-A076 936/4 PC A07/MF A01

ACCESSION NO. EMCABS 9-80-30

ABSTRACT: This study has as its objective the improvement of the protection provided by the military services to military personnel and members of the general public from the hazards of electromagnetic radiation (EMR) of military communications and radar systems. The focus of the investigation is on the area of the electromagnetic spectrum from 30 Hz to 300 Gegahertz. As part of the investigation, the nature of EMR with respect to its interaction with biological matter is reviewed, and the extent of the hazard created by EMR at various frequencies is examined. The extent of military involvement with systems that emit EMR and with research into the hazards of EMR is detailed. An analysis of the military services protective measures, both physical and administrative, is made. Investigation reveals that there are several areas in which the individual services could improve their protective measures by adopting measures in use in other services.

INDEX TERMS: Hazards, electromagnetic radiation (EMR), interaction biological, protective measures.

Electrically Conductive Bonding Strap for Connecting Movable Parts
Arlo K. Palmer, Patent, Filed 30 Mar 78, patented 27
Dept. of the Air Force Washington DC
Nov 79, 4p AD-D006 720/7, PAT-APPL-981 873 Supersedes PAT-APPL-891 873-78, AD-D004 944, Patent-4 175 812, Not available NTS

ACCESSION NO. EMCABS 9-80-31

ABSTRACT: The inventions comprises a braided wire having a shaped clip soldered or otherwise connected to each end. The clip is so formed as to follow the shape of a retainer which is designed to secure a rubber weather seal by means a cable and groove arrangement. (Author)

AVAILABILITY: This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of patent available Commissioner of Patents, Washington, DC 20231 - $0.50

INDEX TERMS: Bonding strap, braided wire, weather seal.

Power Electronics Technology Applications for Future SSBNs - FY 78. Switching Mode Power Supply Designs are Compatible with Sensitive SSBN Circuits. E. Kamm
Naval Ocean Systems Center San Diego, CA
Final Report 1 Aug 79, 66 p Report no. NOSC/TR-443
AD-A076 209/6 PC A04/MF A01

ACCESSION NO. EMCABS 9-80-32

ABSTRACT: The impact of switching-regulator noise on sensitive communication circuits is investigated. State-of-the-art switching-mode power supplies are shown to be compatible with sensitive receiver circuits including low frequency receivers. Recent advances in component design and circuit design techniques that curtail or contain electromagnetic interference (EMI) in switching-mode converters are discussed. The frequency spectrums of the powerline-conducted EMI are analyzed for both ac and dc input designs. By using an optimally designed input filter, the emission caused by the switching action is shown to be less than expected new CE-03 limits for MIL-STD-461A. A major breakthrough in reducing EMI is a recently developed topology for switching-mode power supplies. Compared to dissipative power supplies, low voltage switching-mode power supplies occupy less volume, weigh less, cost less, and use less energy. (Author)

INDEX TERMS: Switching-regulator noise, switching-mode power supplies, powerline-conducted EMI.

Radio Noise Survey Procedures for a Communication Site: 0.15 - 30 MHz
W. R. Lauber, and C. J. Pike
Communications Research Centre, Ottawa (Ontario).
Aug 79, 51 p CRC-1325, N79-33378/7 PC A04/MF A01

ACCESSION NO. EMCABS 9-80-33

ABSTRACT: A step-by-step plan for performing a radio noise survey at a communication site is provided. The data obtained in the survey are used to describe the radio noise environment at the site and may be used to see if a good site is deteriorating or a bad site is improving. The general plan allows for some variation, as each site is different, but is strict enough for compatible results. The measurement data is described as well as ways to analyze and use them in order to evaluate the site. Details for future reassessment are presented. Instructions on the use of basic data for communication system design and system performance prediction are given.

INDEX TERMS: Radio noise survey, communication site, radio noise environment.

Lightning Detection and Ranging System Ldar System Description and Performance Objectives
H. A. Poehler, and C. L. Lennon
National Aeronautics and Space Administration John F. Kennedy Space Center, Cocoa Beach, Fla.
20 Jun 79, 86 p NASA-TM-74105, N79-33672/3, PC A05/MF A01

ACCESSION NO. EMCABS 9-80-34

ABSTRACT: The instruments used at the six remote stations to measure both the time-of-arrival of the envelope of the pulsed 60 MHz to 80 MHz portion of the RF signal emitted by lightning,and the electric field waveforms are described as well as the two methods of transmitting the signal to the central station. Other topics discussed include data processing, recording, and reduction techniques and the softwave used for the 2100S, 2114, and 2116 computers.

INDEX TERMS: Lightning Detection and Ranging System, Ldar, RF signal emitted by lightning, electric field, data processing.

Review of Lightning Protection Technology for Tall Structures Held at the Lyndon B. Johnson Space Flight Center Houston, Texas November 6, 1975.
Office of Naval Research Arlington VA
31 Jan 77, 285 p, AD-A075 449/9, PC A13/MF A01

ACCESSION NO. EMCABS 9-80-35

ABSTRACT: The collection of papers and reported discussions in this volume represent an attempt to make some evaluation of the ability of corona-point arrays to absorb, suppress, eliminate, or in some way, protect against direct strike of lightning to surface structures. Those impaneled for the review and disucssion are from among the best informed investigators of lightning phenomena in this country.

INDEX TERMS: Lightning protection technology, corona-point arrays.

Electromagnetic Shielding Formulas

E. Dahlberg
Royal Inst. of Tech., Stockholm (Sweden) Dept. of Plasma Physics
Feb 79, 41 p TRITA-EPP-79-01 Misc-Addendum to Trl TA-EPP-75-27 N79-32449/7 PC A03/MF A01

ACCESSION NO. EMCABS 9-80-36

ABSTRACT: This collection of electromagnetic shielding formulas contains simple transfer matirces suitable for calculating the quasi static shielding efficiency for multiple transverse-field and axial-field cylindrical and spherical shields. They are also useful for estimating leakage fields from long coaxial cables and the normal-incidence transmission of a plane wave through a multiple plane shield. The differences and similarities between these cases are illustrated by means of equivalent circuits and transmission line analogies. A discussion of a possible heuristic improvement on some shielding formulas is included.

INDEX TERMS: Shielding, electromagnetic shielding, transfer matrices, uasi static shielding efficiency, multiple transverse-field, cylindrical and

IN MY VIEW

P. A. FIELD

ON COMMITTEES

During the courses of their careers, most professional people are asked or required to serve on committees. Some of these serve a useful purpose, but many of them don't. It is not unusual, in fact, to discover that the slow and ponderous deliberations of a committee can hamper, rather than improve, organizational efficiency.

Many organizations, particularly in government where job-security-conscious individuals are singularly reluctant to make decisions on their own, tend to set up committees that require the regular attendance (say once each week) of high-salaried people who spend many hours to arrive at cautious, often tentative, decisions that could be made by one competent, knowledgeable, unequivocal individual in a matter of minutes. This is a tremendous waste of people's time and is very costly in terms of money.

As one who, in past employment as a government employee, has wasted countless hours in committee meetings convened to consider straightforward routine matters that I could have easily disposed of alone in about five minutes, I am in complete accord with the ancient piece of Chinese wisdom that states: "He who deliberates fully before taking a step will spend his entire life on one leg."

But, just what is a committee?
According to one wise wag, it consists of a group of people dedicated to keeping minutes and wasting hours. Another authority has defined a committee as a group of the unprepared, appointed by the unwilling to do the unnecessary.

An editorial in the United Church Observer of March, 1966, has this to say about committees: "Call a committee and an issue will emerge; every issue necessitates the appointment of two more committees which in turn will spawn more committees. Eventually.... life may become one continuous committee that will go on and on so no one will ever have time to write a report, read the minutes, or take any action." Although this editorial was concerned mainly with church matters, it is somehow reminiscent to me of life in the government services.

Apropos of this, at one stage of my professional life, I worked for a branch of the government where the decision-making processes were undertaken by management committees rather than by the head of the Brass section. Laboring under the delusion that this was an organization, rather than an almost certain indication of managerial weakness, those responsible were utterly unaware of the time-tested aphorism: "When an organization needs a management committee, what it really needs is a new manager." In this case, the axiom was particularly apropos. It enabled the head man and those closest to him to divide and evade responsibility, by-pass opposition, and take refuge in the Olympian heights of the board room, completely isolated from the mainstream of the work-a-day activities of the organization to which they were appointed to provide direction.

Many committees set up to convene with mind-dulling regularity tend to become ends unto themselves, so that eventually their original purpose becomes lost in the limbo. In these, over a period of time, the proceedings tend to follow the path of least resistance, so that eventually the built-in inertia keeps the committee going around and around in circles with a minimum of effort. Perhaps, that is what Heraculus had in mind in 500 B.C. when he noted that in the circumference of a circle the beginning and the end are common. It starts nowhere and goes nowhere, which could be an apt definition of what some committees do.

Committees are sometimes used as a cover-up for lack of action. When pressed for decisions, the head man can always fall back on the time-worn excuse that the committee, or the cabinet, or whatever, has not had time to consider the matter - but, it will, this year, next year, sometime, never!

Those who serve on committees regularly know that nearly all of them have their wise guys who claim to know all the facts - and how to twist them to their own advantages. If these promoters are not balanced by other concerned members who take time to probe and query these so-called facts and then weigh them with deliberation so that they can be considered in their proper perspective, then the decisions arrived at in the meetings can rightfully be considered suspect.

And now a few words of wisdom for those who serve on committees:

"It takes just as much effort to solve a useless problem as a useful one."
(C. F. Kettering)

"Don't be afraid of opposition. Remember, a kite rises against the wind."
(Hamilton Mabie)

"To gain one's own way is no escape from the responsibility for an inferior solution."
(Winston Churchill)

"People believe what it pays them to believe, and hardly anyone will accept an idea that jeopardizes his security or threatens his self-esteem."
(Sydney Harris)

And since there always has to be considerable give-and-take among the members of most committees, the person is wise who remembers that one effective way to compromise is to approach a controversial matter through different doors, and then meet in the middle.

(Reprinted from the EMS Newsletter, June 1980)

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JOSEPH E KIDRON
HIROSHI KIKUCHI
LEE W KIL
SUNG S KIM
WOO Y KIM
HISAO KIMURA
JOHN W KINCAID JR
C F KING
COLIN M KING
RONOLD W F KING
C E KIRK JR
J A KIRTLAND
REUVEN KITAI
MAKOTO KITAZAWA
TOMMY L KJELLANDER
DAVID T KJELLQUIST
WILLIAM KLATT
G H KLAUS
EBERHARD KLEIN
IRVING C KLEPPER
JAMES C KLOUDA
JAMES E KLUGE
PAUL KNIGHT
JAMES L KNIGHTEN
BERND K KNOBR
NORMANDIE E KNOOP
EUGENE C KNOWLES
DALE A KNOX
H L KNUDSEN
SADAO KOBAYASHI
LOUIS J KOCOTAS
K W KOERITZ
KYUNG SHIK KOH
FRANK K KOICE
BRUNO KOINZ
TAKIS KONSTANTOPOULOS
G F KOPECKY
ALBAN J KORDALEWSKI
JOSEPH P KOSIARSKI
CHESTER E KOSIOREK
HARVEY KOSTINSKY
W C KOTHEIMER
FRANCOIS KOVER
WILLIAM A KOWNACKI
CARRELL J KRATZER
SEYMOUR KREVSKY
KENNETH F KRIEG
LAWRENCE V KRIGER
JEROME V KRINOCK
R S KRISHNASWAMY
CLIFFORD M KROWNE
J J KRSTANSKY
WILLIAM R KRUESI
ROBERT G KRUPP
S J KUBINA
EDWARD F KUESTER
BRIAN P KUHLMAN
R A KULINYI
GEORGE M KUNKEL
SHOICHI KUNORI
KARL S KUNZ
JOHN A KUYPERS
BORIS KVIZ
GAULT P L H
E LAEIN
MARVIN LAEOWITZ
G E LACHENMEIER
HARRY A LAETT
R E LAFFERTY
MARCELINO LAGE
MILORED A LAHR
L H LAITINEN
J LANAGNA
N V LANASNEY

WILLIAM S LAMBDIN
JAMES C LAMBERT
DIMITRIS P LAMBOUSSIS
WALTER LANDAUER
E J LANE
JOHN P LANE
R F LANE
GEOFFREY M LANGDON
THOMAS J LANGE
INGVAR F E LANGLET
HAROLD F LANIER
EWELL W LANSFORD JR
VICTOR D LAROCK
EZRA B LARSEN
KENNETH W LARSEN
ROBERT R LASH
PAUL E LAT
JAMES C LATIMER
JOHN N LATTA
YUI TIM LAU
G F LAUE
W R LAUBER
KALEVI LAUKKANEN
PUSHPAMALA LAURIN
RALPH M LAWTON
R E LAZARCHIK
MARY F LEAHY
JOSEPH W LECHLEIDER
DAVID LEE
J D LEE
JERRY C LEE
LAWRENCE T LEE
MIN J LEE
YONG S LEE
V G LEENERTS
L G LEIST
WILLIAM S LEITCH
GEORGE M LEMANCZYK
RICHARD P LENTZ
RONALD R LENTZ
CHEUNG K LEONG
JACKIE LEONG
J M LEOPOLD
JOHN F LESCHER
GORDON D LEVEY
JACK G LEVINE
ALVIN S LEVY
EDWIN G LEWIS
FRANK D LEWIS
ROBERT O LEWIS JR
SHING T LI
SAM Y LIAO
LOUIS F LIBERO JR
SHARON A LIEBERMAN
ARTHUR H LIGHT
DANIEL F LILLIE JR
B LINDEMAN
T L LINDSTROM
AUGUST J LINK
E T LIPSCOME
M E LIPTHAY
ROBERT L LITTLER II
TZE-HWA LIU
ROBERT H LIVINGSTONE
PER ERIK G LJUNG
THOMAS W LO
DOUGLAS LOCKIE
J E LOCKYER
JOSEPH M LOGNEY
R J LOPEZ DE ZAVALIA
F J LOPEZ FRANCO
LARRY P LOW
CLARK E LOWMAN
DAVID G LUBAR
HARRY R LUECKE
HERNAN LUCERO
J F LUDFORD
E L LUKE
H D LUKE
NELS G LUNDGREN
STIG A LUNDQUIST
M N LUSTGARTEN
JOHN L LUZWICK
SOREN K LYNGGAARD
J-A-M LYON
F L LYONS
T C MAC ALLISTER JR
W S MAC KELVIE
JAMES H MACEMON
IAN P MACFARLANE
ROBERT L MACDEX
HUGH C MACDOCKS
W M MACDOX
PETER J MACLE
TERRENCE J MAGUIRE
ERNEST A MAGYAR
KANAIYA P MAHENDRA
THOMAS L MAHONEY
ROBERT H MAIER
SHELDON W MAINS
MICHAEL A MAIUZZO
P A MAJOR
J A MALACK
PAUL J MALINARIC
MICHAEL MALINICK
GWYNETH H MALLINSON
EDGAR R MALLORY
V J MANCINO
ENRIQUE MANDADO
EZRA B MANN III
THOMAS J MANSON
MOHAMED A MANSOUR
LEON MAR
JOHN MARDIROSIAN
ANDRE MARQUINAUD
LENNART C MARIN
JESUS A MARISCAL
MEYER MARKS
LAURENT MARQUIS
STANLEY V MARSHALL
F T MARTH
ALBERT R MARTIN
GARY P MARTIN
LEROY C MARTIN
FRANCISCO X MARTINEZ
JOHN N MARTOCCI
E L MARVEN SR
GABRIELE MARZOCCHI
RICHARD P MASSEY
K MASSUDA
R W MASTERS
LAURENCE F MATOLA
FREDRICK MATOS
DON H MATSUMIYA
AKIO MATSUMOTO
G MATSUMOTO
DONALD W MATTESON
HARRY G MAURER
A J MAURIELLO
J R MAUTZ
W W MAY
F MAYER
G F MC CLURE
S C MC COLLUM
WILLIAM S MC CORMICK
I L MC COY
J M MC CUTCHEN
FRANK J MC DONALD
JAMES D MC DONALD
FRANK R MC ELVAIN
DAVID E MC ELVEIN
R MC GEE
C ALBERT MC KAY
GEOFFREY R MC LAUGHLIN
J C MC LAUGHLIN
J S MC LEOD
JAMES G MC NELLIS
R R MC PHERSON
MARION E MCCALEB
JOHN P MCCARTHY
V MCCONNELL
ROBERT F MCCUTCHEON
THOMAS J MCDERMOTT
WILLIAM R MCDONALD
IAN G MCINNES
R W MCKEEEY
LINDA M MCKINNON
J D MCNEILL
R MEAD
H P MEISINGER
JERRY E MENIKHEIM
LAZAROS F MERAKOS
DAVID E MEREWETHER
GEORGE MERKEL
JOHN E MERRELL
H K MERTEL
WILLIAM T METCALF
GABRIEL V MEYER
J A MEYER
OREST A MEYKAR
KRZYSZTOF A MICHALSKI
DAVID MIDDLETON
G B MIGNEAULT
W P MIKELONIS
JOSEPH R MILETTA
CRAIG J MILLER
D A MILLER
KENNETH M MILLER
WALTER M MILLER
CAREY W MILLIGAN
MARK R MILLS
L MILTON
PHILIP C MINOR
FUMIO MINOZUMA
S R MISHRA
D T MITCHELL
WAYNE T MITCHELL
S P MITO
SHOTA MIYAIRI
EISUKE MIYASAKA
JOSEPH M MOCKUS
OSAMA A MOHAMMED
ROBERT C MOHR
H J MOHR
R J MOHR
FRANS MOHRING
KEYHAN MOLAVI
DAVID W MOLNAR
JAMES P MONTGOMERY
MARIA J MONUSKO
MITCHELL L MOODY
CHUN Y MOON
DONALD L MOORE
JOHN G MOOSE
VICTOR MORATS
J J MORF
MICHAEL A MORGAN
TAKASHI MORI
STEPHEN K MORIKI
SUNAO MORISADA
WLADYSLAW W MORON
MICHAEL P MORRIS
P MORRISON
W B MORTON
J R MOSER
JAMES R MOSER
L F MOSES
DAVID R MOSS
FREDERICK R MOTTER
CARLOS MOYETON
JAMES P MULLIGAN JR
KURUSAMY MUNIAPPAN
ARTHUR W MURPHY
J P MURRAY
SISTLA S MURTY
CHARLES E MUTCHLER
B L MYERS
JAMES H MYERS
RICHARD T MYERS
MUNA S NAEILSI
Y NAGASAWA
HIDEYO NAGASHIMA
AHMED H NAGIA
SENICHIRO NAKANISHI
EDWARD M NAKAUCHI
A NALBANDIAN
ALI P NALEANDOGLO
CARLO N NALDI
TOSHIHIKO NAMEKAWA
VED P NANDA
M S NARASIMHAN
J J NARESKY
ANTHONY T NASUTA JR
V S NAZIR-AHMED
FRANK A NEIDIGH
STEWART NELLIS
CHARLES G NELSON
J W NESTING
WERNER E NEUMAN
DONALD E NEUMANN
R H NEWCOMB
P D NEWHOUSE
EDWARD NEWMAN
M M NEWMAN
DEREK NEWTON
EUGENE C NGAI
F J NICHOLS
JUNIOR R NICHOLSON
PAUL NIELSEN
HAROLD E NILES
JOHN A NILSEN
B N NILSSON
MAKOTO NISHI
MASAHIDE NISHIDA
SADAHIKO NISHIMURA
TARO NISHIZAKI
ENRIQUE G NOA
RAYMOND J NOEL JR
MARK J A NOLEN
K S NORDBY
JAMES E NORMAN
LEE E NORTHCROSS JR
M NUNOTO
R D NUSSEAUM
R E OAKES
JAMES W OAKLEY
SUKIRO OBATA
MYLES A OBYRNE
H B OGASIAN
JOHN E OHLSON
NOBUO OHMORI
TOYOAKI OHMORI
TEIJI OHTA
NOBUHIRO OHTANT
IKUO OKA
FUMIAKI OKADA
MASAJI OKADA
TAKASHI OKAMOTO
KENZO OKUDA
J G OLIN
STIG G OLLMAR
ALVAR OLSSON
MURRAY OLYPHANT JR
SHUNICHI OMORI
JOHN J ONEIL
LAWRENCE P ONEILL
FEDERICK J OREILLY
FRANCISCO ORTIZ NIETO
HISASHI OSAWA
B W OSBORNE
CHESTER G OSHELL JR
H W OTT
GUY L OTTINGER
S D OVEREY
WILLIAM W OVERMON JR

THOMAS E OWEN
W D OWSLEY
VICTOR H PADULA-PINTOS
PIETRO PAGLIARULO
W E PAKALA
RAGHUVEER PALLAPOTHU
CHARLOTTE M PALMGREN
CARMEN A PALUDI JR
L R PANGBURN
H N PANTTAJA
EVANGELOS V PAPPAS
NELSON D PARADA
PATEL PARBHU
BYONG K PARK
A T PARKER
JAMES C PARKER JR
WILLIAM H PARKER
R D PARLOW
MERLE E PARMER
VALENTIN M PARRA
DAVID F PARSONS
GEORGE PASSALIDIS
B A PATTAN
JOHN W PATTERSON
ARUN K PATTNI
ROBERT J PATTON
ALVIN W PAUL
CLAYTON R PAUL
DEAN N PAUL
JOSEPH C PAULAKONIS
C B PEARLSTON JR
L WILSON PEARSON
JAMES K PECKOL
PHILIP C PEDERSEN
JOSEPH K PEEBLES
WARREN C PEELE
P A PEISER
JEAN-D PELLETIER
DONALD G PELLINEN
RODNEY A PERALA
P PERINGER
MARK D PERKINS
THOMAS C PERKINS 3RD
SOL PERLMAN
D M PERCZEK
A J PERRELLA
S I PERRY
C PETER
JOHN B PETERS
A L PETERSON
DAVID J PETERSON
FRANK C PETHEL
GHERY S PETTIT
WAYNE C PFANNKUCH
DONALD R PFLUG
W F PICKETT
MICHAEL PIHLMAN
R H PINTELL
U PIZZARELLI
F PLATT
PAUL J PLISHNER
J ANDERSON PLUMER JR
WILLIAM F PODLENA
NELSON V POLLACK
R F POLLACK
GEORGE G POLLOCK
MITCHELL POPICK
RAFAEL PORTAENCASA
W E PORTER
JOSE C PORTOLES
FRANK J POTTER
DAVID M POZAR
L J PRESCOTT
TILLMAN A PRESTWOOD JR
JAMES F PREWITT
PETER J PRICE
RUSSELL E PRICE
ROBIN I PRIMICH
ALAIN PRIOU
STAN PRO
P A PROBST
LEONARD J PROPER
J F PRORCK
JAMES E PROSPER
WM J PRYSNER
EUGENIO A PUENTE
HUGO F PUES
VINCENT G PUGLIELLI
W R PURCELL
WILLIAM L PUSKAS
RALPH H QUEEN
DAVID P QUINN
JUNG-WOONG RA
RICHARD E RABE
THOMAS E RACINE
EMMONS R RADFORD
D S RADMACHER
LESLIE S RADNAY
MARK E RALPH
BOBBY D RAMSEY
EDWARD T RAMSHAW
H RANDALL
V RANFELT
ISAAC RAPAPORT
H RAPPAPORT
R R RASCHKE
ABUL RASHID
D R RASLEY
A R RASMUSSEN
E R RATHBUN
VINCENT E RAVO
J W RAWLEY
DARRYL P RAY
JACOB F RECHAVI
G R REDINBO
D R REED
R R REED
WILLARD A REENSTRA
J S REESE
JOHN G REHAK
THOMAS M REIDY
JOHN J REILLY
ALVIN REINER
PIERRE RENARD
J J RENNER
M REVZIN
E M REYNER 2ND
WILLIAM T RHOADES
JAMES S RICE
HAROLD R RICHMAN
PETER L RICHMAN
L P RICHMOND
GORDON L RILEY
SHERMAN A RINKEL
LAWRENCE W RISPIN
ALWYN C ROBERTS
CARLOS ROBERTS
MICHAEL A ROBERTS
W K ROBERTS
D W ROBERTSON
J G ROBINSON
J H ROBINSON 3RD
HUGH J ROBINSON III
ARNOLD RODEWALD
E M RODRIGUEZ CHATRUC
JAMES M ROE
VALERIE K ROGERS
L ROHDE
THOMAS M ROHERTY
J ROMAN
DIEGO M ROMERO
MORTON RONEY
ROBERT B ROOSE
E C ROSE
IRVING E ROSENBARKER
J ROSENBAUM
ROBERT E ROSENBERG
RAYNER K ROSICH
P L ROSS
ALLEN L ROSSMILLER
R F ROTH
R A ROTHENBERG
GERALD P ROTHHAMMER
PHILLIP J ROUX
CHRISTIAN F ROVSING
J RUBIN
S RUBIN
JAMES W RUCH
F S RUDD
R C RUDDUCK
A RUDZITIS
THOMAS M RUEHLE
PAUL S RUGGERA
JOHN G RUPPEL
THEODORE A RUPPRECHT
ALI M RUSHDI
J RUSKIN
JASON RUSSOMANNO
J W RYAN JR
TIMOTHY J RYAN
W R RYAN
ROBERT R RYASON
JOSEPH L RYERSON
S SAGAROFF
HERBERT M SACHS
STEVEN L SAHAJDAK
YOSHIAKI SAITO
TATSUNORI SAKATA
MOHAMMAD K SAMARKANDY
DONALD E SAMEK
YUKIHARU SAMESHIMA
J J SAMUELI
DALE SAMUELSON
GUSTAVO SANCHEZ
PHILLIP A SANDFORD
KERBY R SANDSTROM
G F SANDY JR
GURDIP S SARAN
DAVID SARKIS
S V SARLE
JUAN A SARMIENTO-CAMPORA
GEORGE L SARVER
R SATO
TOSHIRO SAWYA
STEPHEN A SAWYER
W A SCANGA
J A SCARONI JR
HANS S SCHAFFNER
HENRY M SCHEEL
CARL L SCHEIRMAN
R R SCHELL
ERIC J SCHIMMEL
EDGAR H SCHLAPS
ROBERT J SCHLENTZ
W A SCHLESINGER
H M SCHLICKE
ROBERT E SCHMAKLER
JOHN R SCHMELZER
C H SCHMITT
O H SCHMITT
LEOPOLD M SCHMUCLER
JOHN P SCHOCK 3RD
SIDNEY W SCHOELLHORN
F W SCHOR
H H SCHREIBER
WERNER A SCHREITMUELLER
HANS H SCHUESSLER
JAMES H SCHUKANTZ
R W SCHULT
RICHARD E SCHULZ
TIM F SCHULZ
HARVEY SCHUMAN
STEFAN SCHUY
ADOLF J SCHWAE
E SCHWARTZ
A H SCHWARZ
NORMAN SCHWARZ
H R SCHWENK
ROLAND SCHWERDTFEGER
GEORGE A SCOTT
J B SCOTT
LARRY D SCOTT
NATHAN SCOTT
WILLIAM W SCOTT PE
LEONARD A SCRUGGS JR
ROBERT R SEACH
R M SEDRO
DAVID A SEGERSON
STEPHEN J SENGER
S SENSIPER
RAIMO SEPPONEN
ARTURO V SERRANO
CHARLES E SETH
R A SETTERSTEN
ROBERT R SEVIGNY
DAVID H SHAFF
DALE D SHAMA
DERRILL F SHANKLE
SAM E SHANKLE
THOMAS P SHANKS
GUSTAVE SHAPIRO
IAN H SHEARMAN
WESLEY W SHELTON JR
W C SHEN
NEAL H SHEPHERD
R A SHEPHERD
SID SHEREFF
HILDA N SHEVACK
YIH SHIAN
TSUKASA SHIGEMITSU
SHIN SHIMADA
AZUMA SHIMIZU
AKIRA SHINODA
R L SHIRROD
M W SHORES
ROY W SHOUP JR
B H SHOWALTER
R M SHOWERS
ROBERT M SHUFFLER SR
HENRY G SHUGARS
LOUIS SHULMAN
K R SIARKIEWICZ
FLOYD G SIEGEL
ALFRED J SIEGMETH
DANIEL J SIGNORE
SHAMON SIKORA
GEORGE F SILBERMANN
TAPIO K SILTANEN
C A SILVER
B E SIMMONS
BEN E SIMMONS
MICHAEL C SIMMONS
THOMAS P SIMS
D B SINCLAIR
GEORGE SINCLAIR
BRIAN SINDER
JITENDRA SINGH
PRAEHU N P SINGH
LEO F SIPICH
JEFFREY N SISSON
M R SITHARAMAN
S SJOGREN
BO F SJOHOLM
J W SKAGGS
ANDREJ SKALINA
EMIL SKOCYPEC
SAMUEL SKOLNIK
E N SKOMAL
NORBERT J SLADEK
STEVE SMANDRA JR
A A SMITH JR
C E SMITH
C L SMITH
HECTOR M SMITH
J R SMITH

BERNARD A SMYE-RUMSBY
JAMES M SNODGRASS
H B SNOW
G SCARDC
JCHN A SCECLESKI
DJAKA SOETRATMA
B A SCKOLOFF
ROY M SOLOMELS
R SCMA
ISAC SCMEYA
A H SONNENSCHEIN
BJARNE SCRENSEN
C A SCRENSEN
I J SORKIN
DAVID F SCUTHWORTH
JAMES A SPAGON
EDWIN A SPEAKMAN
PETER SPENCER
WOLFGANG SPLETTSTOBER
CLARENCE E STANLEY
DCNALD E STARK
G R STEELE
CLINTON K STEFFAN
PETER STEINER
G V STELZENMULLER JR
JAN STERN
GREGORY STETSKI
REDMOND C STEVENS
DENNIS G STEWART
JAMES R STEWART
MERRILL G STILES
H J STINGER
RCNALD J STOJACK
DIETER K STOLL
ARTHUR L STONE
DAVIS P STONE
M V F STONE
THOMAS W STONE
CHRIS B STOUT
BRADLEY J STRAIT
FRANK D STRAKA
RICHARD L STRATTON
ROY F STRATTON
ALFRED C STRING JR
DAVID STRONG
RYSZARD G STRUZAK
WILLIAM D STUART
OSKAR E STUERZINGER
F L STUMPERS
R SUBBAYYAN
GEORGE R SUET
STEPHEN SUCKENIK
GARY M SUDDRETH
SURESH SUDERA
R H SUGARMAN
PARK K SUH
CHATE SUKHAPANPOTARAM
A H SULLIVAN JR
G G SUNDBERG
MICHAEL M SUTHERLAND
HIROFUMI SUZUKI
KOU SUZUKI
TCHEU SUZUKI
VITO A SVELTO
M R SWANA
ELSTON H SWANSON
EDWIN SWEETMAN
W D SWIFT
RICHARD N SWINK
I SWITZER
B A SYRETT
EDWARD A SZADZIEWICZ
L SZANTO
BALINT T SZENTKUTI
JUNJI TADA
FERNANDO C TADDEI
ALLEN TAFLOVE
H E TAGGART
TASUKU TAKAGI
AKIRA TAKAHASHI
FUMIHIKO TAKAHASHI
HIROSHI TAKAMI
DAIJI TAKETOMI
SUMIO TAKEUCHI
YOSHIHIRO TANADA
IKUO TANAKA
TATSUO TANIGUCHI
J A TANNER
BASIL M TARALESHKOV
ROBERT T TARLOWSKI
JOHN J TARY
WILLIAM E TATE
MARK A TAUBE
IRVING TAUBMAN
LASZLO TAUSZIG
CLAYBORNE D TAYLOR
HERBERT H TAYLOR JR
R E TAYLOR
WILLIAM L TAYLOR
RICHARD A TELL
JOHN W TENZA
FREDERICK M TESCHE
PHOTIOS J TETENES
PAIRASH THAJCHAYAPONG
RICHARD THAYER
G A THIELE
LEONARD W THOMAS SR
LEONARD W THOMAS JR
ALEX S THOMPSON
LARRY D THOMPSON
R H THOMPSON
GUNNAR TIDEMANN
HENK A T TIMMERS
E M TINGLEY JR
JOHN C TIPPET
J C TOLER
RYUICHI TOMIYASU
EVANGELOS TONAS
STANKO TONKOVIC
DONALD S TOOMB
A A TOPPETO
CHING P TOU
CHARLES E TOUHY
CARLO TRABUSTI
PHILLIP G TREMPER
DANIEL L TRIEBLE
M TRIEB
RICHARD R TROOP
C W TRUEMAN
KATSUMI TSUJIMURA
YOSHINOBU TSUKADA
B A TUELING
LUIS R TUNIALAN
EMIL E TUREK
VICTOR M TURESIN
CHARLES F TURNER
PAUL F TURNER
JAY F TUTTLE
C J TVEIT
THOMAS S TYCZ
CHARLOTTE R TYSON
MASAMI UCHINAMI
KATSUHIKO UEMURA
G R UFEN
E R UHLIG
KORADA R UMASHANKAR
TERUHIRO UMEZU
TADAO UNO
KLAUS O UOISTINEN
LOUIS J URBAN
CALVIN B URSERY
GOKHAN UZGOREN
JEAN P VAERE
LAURENCE J VACLAVIK
ANTHONY R VALENTINO
ELLIOTT P VALKENBURG
RICARDO VALLE-SANCHEZ
J G VAN BLADEL
MICHAEL L VAN BLARICUM
RON VAN BRENK
JOHN F VAN SAVAGE
G N VAN STEENBERG
V J VAN VELZER
J A VAN VOORTHUIZEN
W VAN WINEGARDEN
EDWARD F VANCE
GARY S VANDEMAN
DENNIS H VANSICKLEN
JOSEPH G VARLEY
LEO I VASKELAINEN
T J VAUGHAN
C G VELEVITCH
THOMAS L VENABLE
RICHARD S VENCUS
GARY R VEST
BALASESHA S VIDULA
W A VISHER
PAUL W VOGEL
ROBERT D VON ROHR
K VONGLOOJANAPORN
W A VOSS
Z F VOYNER
BRUCE C VRIELAND
P W WADDINGTON
REINHARD R WAIBEL
FRANK S WAITKUS
TOSHIO WAKABAYASHI
EMIL J WALCEK
LAWRENCE C WALKO
LESLIE A WALL
R B WALLACE
ROBERT F WALLENBERG
JOHN J WALLS
RICHARD T WALTER
ROBERT O WANSELOW
FRANK W WARBURTON
JOHN K WARDROPPER
LARRY K WARNE
F C WARNER
S M WARREN
RAYMOND P WASHBURN
G C WATFORD
M N WATINE
C E WATKINS
ROBERT E WATTS
DANIEL G WAYNE
DONALD A WEBER
E W WEBER
DAVID O WEDDLE
GUNNAR WEDELL
URS WEGMANN
JOHN C WEIDNER
GLEN L WEINBERG
D D WEINER
BRUNO O WEINSCHEL
KNUD-V WEISBERG
RICHARD F WEISPFENNING
SUSAN D WEISS
MARK A WEISSBERGER
W A WEISSMAN
THERON C WELLS
WILLIAM C WELLS
J WELSH
L WERNER
EDWIN P WESTBROOK
B WESTERHULT
EDWARD E WETHERHOLD
JAMES J WHALEN
B G WHEELER
CHARLES C WHITE JR
DONALD R WHITE
R J WHITE
RANDALL R WHITE
G C WHITELEY JR
C D WHITESCARVER
CARROLL WHITSON
A C WHITTLESEY
ELDEN E WICK
WALTER R WIDMER
THOMAS B WIGGINS
JAMES WIGHT
MANUEL W WIK
TORO C WIKZEN
R G WILEY
C P WILKES
J H WILKINSON
WILFRID S WILKINSON
ROGER V WILLEY
DOUGLAS L WILLIAMS
JACK D WILLIAMS
L D WILLIAMS
PHILIP C WILLIAMS
STEVEN L WILLIAMS
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EMI/EMC, shield, enc. consult. test. & anal.; Scrn. rm. (incl. for large veh.); Comp. instr. for Mil. EMI test.

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METEX ELECTRONIC SHIELDING GROUP, A Unit of Metex Corporation, 970 New Durham Road, Edison, NJ 08817

EMI/RFI, EMP & EMC Shielding Materials, Custom-Engineered Conductive Components, and Coatings.

TECKNIT, INC., 320 N. Nopal St., Santa Barbara, CA 93103

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HONEYWELL, ANNAPOLIS OPERATION, P. O. BOX 391, Annapolis, MD 21404
Telephone (301) 224-4500

EMI/EMC/TEMPEST, R & D, Test and Analysis, Communication and Digital Design.

CHOMERICS, INC., 77 Dragon Ct., Woburn, MA 01801
Telephone (617) 935-4850

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SPECTRUM CONTROL, INC., 8061 Avonia Rd., Fairview, PA 16415
Telephone (814) 474-i571 Telex 510/699-6848

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LECTROMAGNETICS, INC., 6056 W. Jefferson Blvd., Los Angeles, CA 90016
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RF shielded enclosures, modular, prefabricated & all welded. RFI/EMI power line filters; signal line filters.

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