IEEE

NEWSLETTER

ELECTROMAGNETIC COMPATIBILITY GROUP

ISSUE NO. 46 | Rexford Daniels, Editor, Monument Street, Concord, Mass. | NOVEMBER 1966

Adcom

HIGHLIGHTS OF OCTOBER 4, 1966 AD COM MEETING

1. Papers for publication in G-EMC Transactions: It was reported that sufficient papers were available for the September and December issues, and a few were available for the March 1967 issue. Sources of papers suitable for publication in the Transactions were discussed. Some suggestions were:

From the San Francisco Symposium
Papers that have been delivered at Chapter meetings

2. Establishment of a "Speakers bureau" to provide a list of speakers who are available to talk on EMC subjects. who may be called upon when talks on EMC are desired.

3. EMC Abstracts: It was estimated that approximately 500 articles of interest to G-EMC were published each year. A proposal was made that these articles be abstracted by an editorial review committee of approximately 15 members with the objective of publishing such abstracts, either separately, or as an addendum to the G-EMC Newsletter. The estimated cost, based on 4 abstracts per page, 10 to 11 pages per month, was $300. 00 per monthly issue or $500. 00 per bi-monthly issue.

4. The proposed agreement for the merger of IEEE Technical Committee 27 with the Group-EMC which was presented at the 11 July 1966 AdCom meeting was accepted, and the secretary was requested to prepare the merger agreement for signatures.

5. G-EMC will adopt the IEEE Calendar year as proposed by the IEEE Technical Activities Board. Details will be worked out.

6. The G-EMC chairman exhorted all AdCom members, Chapter chairmen and Chairmen of Standing Committees to review their responsibilities and to seriously undertake them.

7. The Chairman requested that he be provided with the names of persons who are available for additional IEEE work in the EMC area.

8. The G-EMC will in the future elect two group vice-chairmen, one for the East Coast and one for the West Coast.

9. The EMC session at the IEEE International Convention will be held at 9:30 a. m. on Monday, March 20, 1967. The program for this session will be a panel discussion on "EMC in System Design."

Report of Chairman — *Herman Garlan, Meetings Committee, October 4, 1966*

"Our Group is participating in the following meetings.

1966 EMC Symposium, San Francisco July 11-13, 1966

"I have received a preliminary final report from Guy Ottinger, Chairman. Briefly, the symposium finances show a surplus of $2400 of income over expense. There were some 260 paid registration, and Ottinger estimates that the total attendance was about 450. The social functions continue to be a problem and Ottinger recommends that the registration fee be increased so that tickets for the luncheon and the banquet can be provided at no additional cost to each registrant. A final report will be forthcoming shortly. Mr. Ottinger's report is attached elsewhere to these minutes.

1967 IEEE Convention, New York, N. Y. March 20-24, 1967

"The 1967 Convention will be organized on the basis of subjects, not on the basis of groups. After some delay we got our bid in for a session on the subject 'EMC in Systems Design." After some discussion, Mr. Sullivan and I agreed to organize this as a panel discussion with speakers representing land mobile area, aerospace area, military area and satellite communications area. I have agreed to be the session organizer, Mr. Sullivan will chair the panel. Tentative commitments have been received from two prospective speakers.

1967 Communications Conference, Minneapolis, Minnesota June 12-14, 1967

"We have been invited to participate and organize a session on EMC at this conference. I advised that I would raise the question at our October 4 AdCom meeting.

1967 EMC Symposium, Washington, D. C. July 18-20, 1967

"Planning is proceeding on schedule. The first call for papers was mailed the end of September. A detailed report will be presented by Mr. Charles Gregory, Assistant Chairman.

1968 EMC Symposium, Seattle, Washington, July 23-25, 1968

"Will be reported on by Dick Schulz.

1969 EMC Symposium

"Nothing to report. Perhaps Mr. Egli will be able to report.

"General Comment: On the whole, our own Symposia have been successful. We still must increase our participation in meetings of other IEEE Groups and of other organizations if we are to spread the gospel of EMC. In this connection I would call attention to a session on Automotive ignition interference at the IEEE Vehicular Conference, Montreal, December 1-2, 1966. Some of our members, notably Mr. Nichols and Mr. Daniels, have been doing just this - speaking on EMC to various (non IEEE) groups. I would strongly urge all the members of EMC to do the same."

Chapter Activities

Chicago:

The following meetings have been held by this Chapter:

January 12, 1966 - Mr. Robert Weston, Federal Communications Commission, Washington, D. C. spoke on "Proposed Senate Bill 1015 on EMC Control."

April 13, 1966 - Mr. Peter Turek, Lear Seigler, Grand Rapids, Michigan, gave a talk on "X-Y Plotter Readout to MIL-I-6181D in Preparation of MIL-STD-826."

May 10, 1966 - A talk was given by Mr. Ray Elsner, IITRI, Chicago, Illinois, on "Environmental Intermodulation for Rusty Bolt Problem."

Los Angeles:

There was meeting held by this Chapter on May 19, 1966 and Mr. Harry Nickerson spoke on "Low Budget EMI Compatibility."

Metropolitan New York:

A meeting was held on May 24, 1966 and Mr. Elliot Markow, Singer-Metrics, delivered a talk regarding the techniques used by the National Bureau of Standards for the calibration of loop and dipole antennas.

Mohawk Valley:

This Chapter held a meeting on April 6, 1966 and Dr. O. Salati, University of Pennsylvania, Philadelphia, Pa., spoke on "Problems in EMC Measurements - Perturbation of EM Fields."

Philadelphia:

There was a meeting held on May 24, 1966 and Mr. R. S. Sugarman, American Electronic Labs., Inc., Colmar, Penna., and Mr. D. R. J. White, White Electromagnetics, Inc., Rockville, Md., spoke on "Automatic EMI/EMC Test Equipment."

San Francisco:

Two meetings have been held by this Chapter: One on January 26, 1966 wherein Dr. Fred Morris, Electromechanics Co., Austin, Texas, gave a talk on "Measurement of Electromagnetic Radiation;" another on May 25, 1966 and Mr. Mike Dix, General Microelectronics, Santa Clara, Calif., and Mr. Benjamin Lee, Fairchild Semiconductor, Mt. View, Calif., spoke on "EMC and Microelectronics."

Seattle:

A meeting was held on May 11, 1966 and Mr. William M. McCullough, The Boeing Company, Seattle, Washington, gave a talk on "Susceptibility of Digital Integrated Circuits."

Washington, D. C.

There was a meeting held on May 12, 1966 and Mr. Richard P. Gifford, General Electric Company, Lynchburg, Virginia, gave a talk on "EMC - Revisited 1966."

Another meeting was held on September 29, 1966 and Mr. Fred Nichols, Genistron, Inc., Los Angeles, California, spoke on "Future Challenges of Electromagnetic Compatibility."

1966 Symposium

REPORT OF GUY L. OTTINGER, CHAIRMAN, 8th IEEE EMC SYMPOSIUM, SAN FRANCISCO, JULY 11-13, 1966

"The 8th IEEE Symposium on Electromagnetic Compatibility was held in San Francisco July 11, 12, 13, 1966. Despite the fact the majority of the nation's transcontinental air lines were on strike, attendance was exceptional. Some 500 engineers, scientists, sales representatives, and executives in the EMC/EMI profession were present.

"The keynote speaker, Brigadier General J. S. Bleymeier, Commander, Air Force Western Test Range, Vandenberg AFB, California, set the stage for the Symposium with his recital of EMC problems and their solutions on the Western Test Range.

"Civilian EMC was emphasized by a technical session devoted solely to this subject. It was felt that in the past most emphasis had been placed on military and NASA EMC, and that it was time to recognize other areas. Topics ranged from Man-Made Noise, Garage Door Opener EMC, EMC and National Forest Land to the RF Arcwelder - A Dilemma in EMC.

"Mr. Ralph Clark, Special Assistant to the Director of Telecommunications Management for International Telecommunications, Executive Office of the President, traced the growth of national and international telecommunications and emphasized the need for EMC break-throughs in frequency utilization and management.

"New developments in EMC Instrumentation attest to the importance of automation of EMC/EMI testing. Three papers in session 4-A were devoted to this very important aspect.

"A session was devoted to the subject of Transient Voltage Testing for EMC Predicting. More and more EMC problems are being attributed to transients as the state of the art progresses and more data becomes available.

"Mr. Herman Garlan, FCC and A. H. Sullivan, Jr., H R B - Singer Co., were given awards of merit for outstanding work in the field of EMC during the past year.

"Dr. Frederick E. Terman, Provost Emeritus, Stanford University, addressed the banquet audience on Engineering Education in the U. S. S. R.

"A panel discussion, Today's Specifications - Tomorrow's Compatibility, chaired by W. D. McKerchar, McDonnell Aircraft, was made up of speakers from this highly specialized field of EMC.

"Department of Defense Agencies are fully aware of the problems and expense involved in the present complex and varying specifications required by the various services. To this end, MIL-STD 461, 462, and 463 are in advanced stages of preparation and are being coordinated throughout industry.

"The Air Force's fully instrumented C-131 Aircraft for electromagnetic environmental studies FSM-17 Three Dimensional Antenna Pattern Analyzer was demonstrated to Symposium attendees as a special field strip. This aircraft stimulated considerable interest - in fact, sufficient time and facilities were not available to accommodate all the would-be visitors.

"The Symposium was fully supported by 24 exhibitors and 14 who displayed or represent the 1967 state of art in equipment, instrumentation and suppression devices."

Paper presented
at 1966 Symposium

DIGITAL COMPUTER PROGRAM FOR DETERMINING THE EFFECT OF HIGH LEVEL RF EXPOSURE ON MISSILE SYSTEMS

The above paper was delivered by Dr. Carl L. Frederick, Senior Scientist, Vitro Laboratories, Silver Spring , Maryland, at the 8th Symposium on EMC. The Summary and first two paragraphs are as follows:

Summary

"Computer programs to help solve EMC problems are needed to reduce the time and cost of predicting the susceptibility and degradation of electronic systems when operating in high level ambient electromagnetic environments. Today, such environments are present everywhere on the surface of the earth, at launch pads, in airborne situations, and in silos below the ground where electrical interference is predominant. Computer programs are needed also in making improvements in system design and testing. The purpose is to quickly assess the risk of an operation in terms of safety, reliability and operational success. A digital computer program capable of meeting these needs is described, using a ladder network model in computing the spectral distribution of power absorbed in an Electrical Initiator of a missile system exposed to high level radio frequency fields. The availability of accurate input source data is essential. 'Receptor' circuits composed of up to 150 radiated sections plus coupling from up to 40 'Interfering' circuits can be handled by the program. The program is written in Fortran IV for 7094 computers.

"The need for a rapid and economical computer program for the purpose of performing preliminary evaluation of the susceptibility of electronic systems to potential degrading effects of interfering input signals, arises from the necessity to reduce the risk of hazards and operational failure. To some extent, all physically realizable systems are susceptible to interfering electromagnetic influences present in any environment. The degree to which a system is susceptible determines the risk in terms of safety, reliability, and operational success. These risks then must be weighed against the time and cost of analytically predicting the degree of degradation and validating the results, by measurement in specific operational environments.

"Documented evidence of the cost of the risks, taken in the past, in terms of loss of life, money and time, has prompted many program managers to insist on a reasonable EMC control plan being applied concurrently with the functional design of electronic systems to assure electromagnetic compatibility."

Copies of this paper may be obtained by writing to:

Mrs. Charlotte F. Wotring
Public Relations Office
14000 Georgia Avenue
Silver Spring, Maryland 20910

EDITORS NOTE

From rumors current in Washington, there are several "earth shattering" government-inspired reports coming out on electromagnetic compatibility and the use of the electromagnetic spectrum. As soon as we can get a hold of them, we will try to digest them for members of G-EMC and publish them in the Newsletter. One of them, we understand, is titled "The Silent Crisis."

Rexford Daniels, Editor
Monument Street
Concord, Mass. 01742

E M C

RESULTS OF SUCCESSFUL COMPLETION OF IEEE G-EMC CHICAGO CHAPTER 1966 EMC TRAINING PROGRAM

The officers of the G-EMC wish to thank the instructors and other individuals (noted below) in the Chicago area for their assistance in accomplishing another successful EMC course.

Mr. Chuck Berry - Motorola, Incorporated
Mr. Robert Andrews - Amphenol
Mr. Joseph Nasca - Licon
Mr. Don Healy - J. C. Angel
Mr. James Krstansky - IITRI
Mr. Fred Parker - Genistron
Mr. Lawrence Fay - Equipto Electronics

The EMC Course was the second successful EMC Training Program presented in the Chicago area under the sponsorship of the IEEE Group on Electromagnetic Compatibility

The course consisted of 5 sessions held each Thursday evening for approximately 2-1/2 hours from April 28 to May 26, 1966. The rooms for the course were obtained from the Illinois Institute of Technology.

The 5 sessions covered the following areas of interest:

1. EMC Terminology and Application of Control Measures presented by Mr. James C. Klouda of Elite Electronic Engineering Company.

2. Application and Interpretation of Specifications presented by Mr. Carl P. Jesperson of Motorola, Incorporated and Mr. William Johnson of the Potter Company.

3. Filter Design presented by Mr. Gerald Shifman of Genistron, Incorporated.

4. Shielding of Cables, Enclosures, Connectors, and Grounding of Systems presented by Mr. Norbert Sladek and Mr. Walter Stebbings of Amphenol and Mr. Stewart Nellis of Technical Wire Products.

5. Applications of EMC Control to Various Types of Electronics Equipment presented by Mr. Jack Bridges and Mr. Irv Mindell of IITRI.

Tuition for the course was $20.00 for IEEE members, $30.00 for non-members.

The attendance for the course was approximately 30 persons every week, with a total registration of 35 people representing 20 different organizations.

After expenses are covered, the Training Committee expects to be able to turn over approximately $450.00 to the Treasurer of Chicago Section.

1967 Symposium

The 1967 Symposium on Electromagnetic Compatibility will be held on July 18, 19, and 20 at the Shoreham Hotel in Washington, D. C. The theme of the meeting "Education, Measurement and Conservation" accents three important aspects of electromagnetic compatibility. Emphasis will be placed on a program designed to interest engineers and scientists engaged in EMC problems. The Technical program committee is actively seeking authors to submit papers that have not been previously published or presented, describing significant contributions in the following areas:

PREDICTION AND ANALYSIS

System Simulation

Environmental Prediction-Ground, Air and Space

Technique Evaluation

INSTRUMENTATION, MEASUREMENT AND TEST

Mil Std Measurements and Specification Compliance

Automated Instrumentation

Radiation Hazards and Transients

SYSTEM COMPATIBILITY

Education - EMC Awareness

Frequency Management

Operational Problems

COMPONENT AND ADVANCED DEVICES FOR EMC

Microelectronics

Integrated Circuits

Suppression Devices

Authors who wish to present papers should submit a summary of approximately 500 words by January 1, 1967. Summaries should be sent to:

Frank T. Mitchell, Jr.
EMC Technical Program Chairman
Jansky & Bailey Engineering Department
Atlantic Research Corporation
Alexandria, Virginia 22314

Authors will be notified of acceptance or rejection by February 1, 1967. Complete manuscripts will be required by May 1 in order to be included in the symposium record to be distributed to all registrants at the conference.

The Department of Defense will sponsor a Tri Service Conference on EMC to be held on July 20, 21, 1967 in coordination with the 1967 EMC Symposium. This conference will feature classified sessions outlining the current DOD programs in EMC. Further information on this conference will be distributed by DOD pending final plans.

MAN-MADE NOISE REPORT AVAILABLE

A Technical Committee working group under the direction of Mr. Jules Deitz, FCC engineer, has completed its study and report on man-made noise. The report has been reviewed by members of the Technical and Executive Committees and, in view of its immediate usefulness to other land mobile groups and as reference material in general, it is being made available at this time to all persons interested in the subject of radio noise and how it affects the land mobile radio service. The report can be obtained from the Office of the Chief Engineer of the FCC, Washington, D. C. 20554.

ELECTROMAGNETIC TESTING (For Inspection of Material)

One of a series of volumes covering the field on nondestructive testing for use in accomplishing quality and reliability assurance operations for Department of Defense material. The purpose of this volume on Electromagnetic Testing is to provide DOD quality and reliability assurance personnel with the basic principles underlying electromagnetic testing techniques. The subject matter covered includes a brief history of the development of electromagnetic testing technology, the theory and principles of electromagnetic testing and test systems, calibration and quality assurance standards, and typical applications of testing techniques. A glossary of electromagnetic testing terms and an appendix of systembolic definitions are provided for the benefit of the reader; a bibliography covers some of the more pertinent references current in the field of electromagnetic testing. 1965, published 1966. 194 p. il. Catalog No. D 7. 6/2:54 $1. 25.

A COMPARISON AND SURVEY OF FLAT GASKET MATERIALS FOR ELECTROMAGNETIC SHIELDING AND SEALING PURPOSES

Metex Corporation, Clark, New Jersey 07066, has brought out a 28-page booklet by Willem F. Bakker and Albert H. Cohen under the above title. There are 21 illustrations showing the composition of the materials tested, the testing set-up and charts of testing results. Copies of the booklet may be obtained by writing to the company. The Abstract is as follows:

> "Five thin (. 062 thick or less) gasketing materials capable of providing an electromagnetic, as well as environmental seal were compared to determine how well they performed their required functions. Evaulations were made on a quantitative basis of resistivity, compression deflection, pressure sealing capability, water sealing capability and electromagnetic attenuation.
>
> "The results indicated that three of the materials tested were significantly better shielding materials than the other two in the electric and plane wave regions of the electromagnetic spectrum. Two of these three also exhibited fair attenuation in the magnetic wave region.
>
> "Several unexpected results turned up. For one, there was very poor correlation between dc resistivity and electromagnetic attenuation. Also, the pressure sealing ability of several of the materials was significantly poorer than plain rubber gaskets.
>
> "What is shown is a series of compared quantitive measurements which leave the designer with enough information to choose whether the materials evaluated meet the various shielding-sealing parameters of the particular application. "

RFI/EMI TEST, MEASUREMENT, AND CONTROL SERVICES

F & M Systems Co., a Division of Fishbach and Moore, Inc., 2525 Walnut Hill Lane, Dallas, Texas 75220, can provide a complete RFI/EMI measurement, analysis, and control capability. F & M has experienced personnel for specialized mobile facilities and equipment which can be dispatched to most installations within 24 hours. The equipment is carried on three motorized vans and one forty-foot tractor van. All include measurement, analysis, and recording equipment to cover the RF spectrum of 30 cps to 15 gc and can perform the following functions:

Military Specification Testing
Integrity Measurements of Shielded Enclosures and Secure Communications
RFI/EMI Source Location
General RFI/EMI Consultation Services.

Notes on Articles of Interest

SHIELDING R-F WITH COPPER FOILS

Under the above title, Norman H. Cale, Metallurgical Engineer, Research & Technical Center, American Brass Company, Waterbury, Conn., has a 2 1/2 page article with two tables in the September 1966 issue of EE Electronic Engineer. Paragraphs of interest are:

> "With new requirements for data on copper foils as r-f shielding, a test program has supplemented and extended the work reported in the article, 'A Comparison of R-F Shielding Materials'. In our new program, the r-f shielding properties of 'Electro-Sheet' copper foils were rechecked from 500kHz to GHz, and extended down to 60 Hz. Various types of joints were investigated and some work included on double thickness of foil. The data here was obtained from a test program done for us by Ark Electronics Corp., Willow Grove, Pa.
>
> "Three foil weights were chosen for the test. These were 1 oz. (0.0017 in. thick), 3 oz. (0.0046 in. thick) and 7 oz. (0.0098 in. thick). The materials were taken from a typical production run.
>
> "Various means of joining were explored to obtain data on the method or methods which would give the best coupling of cost and effect for the attenuation level required. The soldered seam had the best data record, either as a continuous or spot soldered joint. However, nailed or stapled seams also gave good attenuation, especially at low frequency. For many commercial shieldings where high attenuation is not needed, this type of joining would save money."

CONTACT PROTECTION FOR ELECTROMAGNETIC RELAYS

Charles C. Bates, Staff Assistant, Sandia Corporation, Albuquerque, N. M., has a 2-page article, under the above title, in the August 1966 issue of Electromechanical Design. The first two paragraphs are as follows:

> "Thirty volt dc circuits may induce voltages as great as 1500 v across relay contacts as they open. Even with resistive loads, contact arcing occurs due to power supply and wiring inductance producing the voltage surge. Contact protection, also known as arc suppression, arc-inhibiting, spark suppression, spark quenching and discharge suppression, assures longevity and reliability of electromagnetic relays.
>
> "Resistors, diodes, Zener diodes, and nonlinear voltage sensitive resistors eliminate or reduce arcing by providing a low resistance path for the induced voltage to dissipate in the load. The induced voltage would otherwise appear across the controlling contacts. Capacitor arc suppression circuits allow the controlling contacts to separate an appreciable distance before a voltage capable of producing an arc appears across them. The table illustrates various techniques of protection."

NEW CONNECTOR AIDS FOR COMBATING RFI

Leonard Bock, Design Engineering, Burndy Corporation, Norwalk, Connecticut, has written a 4-page article, under the above title, in the August 1966 issue of Electronic Packaging and Production. This paper was originally presented during Technical Session VI at NEP/CON '66. The first paragraph is as follows:

> "Ground loops, oscillations and feedback are typical of the RFI problems in modern electronic equipment which can be resolved by use of the techniques described here. The problem of RFI is compounded when package size is reduced since interfering signals, and the circuits which are sensitive to these signals, are brought closer together. In order to deal with this the packaging engineer is often forced to replace single conductors with coaxial or shielded cables to protect sensitive circuitry. Further, it is often necessary to common the shields of the cables, leading to additional hardware which adds to the size and cost of the package. This is particularly true when provision for maintenance requires that individual contacts be removable for replacement or circuit changes."

EMI-PROOFING MIL-SPEC CONNECTORS

Walter E. Stubbings, Engineering Project Manager, Amphenol Connector Div., Amphenol Corp., Chicago, Ill., has a 3-page article, with the above title, in the July 1966 issue of EDN. Paragraphs of interest are as follows:

> The ever-increasing emphasis on shielding systems and components from electromagnetic interference has led to the development of new and improved methods and materials. Here is a quick look at current connector-shielding techniques.
>
> "Shielding is particularly important for electrical connectors carrying critical signal and control circuits in missile and space applications, since spurious EMI signals could cause premature squib firings or other serious malfunctions. Making a connector EMI-proof is a matter of degree. In applications where EMI is minimal or where circuits are not critical, the basic metallic shell design of connectors usually provides sufficient shielding. However, when connectors are used in intense EMI fields, better shielding is required.
>
> "Since connectors meeting MIL Specs MIL-C-26500 and 38300 are widely used in missile and aircraft applications, research and design studies are being carried out at an accelerated rate to increase their shielding effectiveness."

OPTIMIZATION OF DIRECTIVITY AND SIGNAL-TO-NOISE RATIO OF AN ARBITRARY ANTENNA ARRAY

Y. T. Lo, S. W. Lee, and Q. H. Lee authored a 13-page article under the above heading in the Proceedings of the IEEE, August 1966. The Abstract is as follows:

"Abstract - In this paper, a unified formulation is made for the optimization of directivity and signal-to-noise ratio of an arbitrary array, with or without a constraint on the array Q-factor. When there is a constraint, the solution is reduced to that of a polynomial; when there is no constraint, the solution is given in a very simple form. First, it is shown that for a given array geometry there exists a finite permissible range of the Q-factor and this range reduces to zero for large spacings. Second, a detailed comparison between four well-known excitations (uniform, Hansen-Woodyard, optimim cophasal, and optimum) is made and the main results are as follows. 1) The Hansen-Woodyard excitation yields a directivity higher than that of the uniform only when the element spacing is somewhat smaller than a half wave-length ($\lambda/2$), but at the price of much higher Q. On the other hand, it is much lower than that of the optimum excitation. 2) For spacing less than $\lambda/2$, the optimum excitation is strongly tapered toward the ends of the array and approximately antiphasa (i. e. , 0, 180° 0, 180°, . . .); whereas for spacing greater than or equal to $\lambda/2$, it is nearly uniform and cophasal. 3) For large spacings, the directivity of uniform excitation is nearly optimum. For small spacings, the optimum directivity becomes much higher than all others, but is always associated with an enormously large Q-factor. Therefore in this case a constraint of the Q-factor is important. 4) Hansen-Woodyard and uniform arrays have the interesting property that their sensitivity factors are independent of spacing.

"The optimization of signal-to-noise ratio is also demonstrated. In particular, the result shows that although an improvement in gain over the uniform excitation is very difficult to realize in practice, a substantial improvement in signal-to-noise ratio is entirely practical. Other numerical results and some extensions of the theory to aperture antennas are also included."

MODAL NETWORK THEORY OF SKIN EFFECT IN FLAT CONDUCTORS

P. Sylvester, McGill University, Montreal, Quebec, Canada, has authored an article in the Proceedings of the IEEE, September 1966, under the above title. The abstract and introduction are as follows:

"Abstract - A new theory of skin effect in linear conductors of arbitrary cross-sectional shape is proposed and illustrated by calculating the ac resistance of a flat conductor. The current flowing in any conductor may be decomposed into an infinite set of normal mode currents, all of which exist independently of each other. Each modal current may be calculated from the conductor terminal conditions by simple circuit theory. Use of this method presupposes knowledge of the normal modes, which are different for every cross-sectional shape. A general method of finding the normal modes is given. Excellent agreement with experimental data is reported.

Introduction

"There exist two classical skin-effect problems for which rigorous analytical solutions have been given to date: the long, straight, round wire or tube, and the infinitely wide flat sheet. The latter is not a good model for flat conductors of finite width, and the solution is of practical use only in the limiting case of a semi-infinite conductive half-space. In that limiting form, the flat plate theory leads to the very useful notion of skin depth, and permits solution of many other problems at high frequencies approximately. There exists an extensive literature dealing with asymptotic solutions, and several approximate solutions have been proposed for rectangular, elliptic, and flat cross sections.

"Dwight (1) has attempted to solve for the skin effect in a flat conductor of finite width, by developing the ratio of effective resistance to dc resistance in a power series in frequency. Alternatively, Belevitch, Gueret, and Lienard (2) have formulated this problem as a Fredholm integral equation, and performed successive integrations numerically on a digital computer. Neither theory has any applicability to other than the ac steady state, and neither has yielded a satisfactory solution to the problem.

"The approach reported here differs from those previously employed. Instead of attempting to solve the pertinent differential or integral equations directly, normal modes of current distribution are first found.

NOISE BEHAVIOR OF AVALANCHING SILICON DIODES

H. T. Minden, Sperry Rand Research Center, Sudbury, Mass. , has a 3-column letter with a chart and four illustrations under the above title in the Proceedings of the IEEE, August 1966. The first three paragraphs are as follows:

"Since the discovery by Johnston et al. (1) of coherent microwave oscillation in avalanching p-n junctions, the question has arisen as to whether these oscillations are a property of the junction as a whole or whether they are connected with breakdown at imperfections (2).

"To examine the junction perfection, we resorted to an experiment first described by McKay (3) and most recently investigated by Haitz et al. (4) Current from a low-impedance source was passed in the reverse direction through the diode and then through a series resistor. The voltage across a 50 Ω resistor was measured on an oscilloscope. Alternatively, the signal was passed through a 10 dB pad to a mixer crystal to measure the noise power. The diodes were made by boron diffusion into phosphorous doped substrates of various resistivities. The breakdown voltages ranged from 30 to 120V and were reproducible for a given material. Both planar and mesa structures were studied. All diodes described showed continuous microwave oscillation with power outputs of between 1 and 20 mW and frequencies between 2 and 10 Gc/s.

"Essentially, two types of breakdown were found. At low currents (1-300 μA) the flat-topped constant pulses associated with microplasmas (5) were observed. These are shown in Fig. 1. The pulse magnitude was typically 10-30 μA. With increasing current the pulse length increased while the interval between pulses decreased. Finally, the microplasma saturated and no 'off' pulses were observed. In many diodes, several sets of pulses would fire simultaneously, each with its own duty factor characteristic of its percent saturation."

IEEE Transactions on Industry and General Applications

PERSONNEL GROUNDING - A CASE HISTORY

IEEE Transactions on Industry and General Applications, September/October 1966, has a 6-page paper with 5 tables by R. M. Lumley and W. J. Neiswender of the Western Electric Company under the above title. The abstract and first paragraph are as follows:

"Abstract - In many semiconductor manufacturing processes, it is necessary that precautions be taken to prevent dissipation of static electrical charges within the devices being manufactured. Often one of the major sources of static electrical charges are the people who are performing the manufacture of the semiconductor devices, and, therefore, if static charges are a problem, provision must be made for elimination of the charge on the personnel. In our studies, it has been found that in certain manufacturing areas it is quite easy to obtain a static charge of 1/2 mC, equivalent to 2500 volts, on a person. Several techniques for eliminating static charge build-up on people were investigated, such as the use of radioactive ion generators, humidity control; electrical grounding, and special clothing. Each area was investigated with respect to such parameters as present availability, hazards to personnel, hazards to product, etc. As a result of the studies, it was found that at present, considering all factors, the best method of preventing static electrical charge accumulation on people is the use of an electrical ground through a resistance.

"It is well known that static electrical charges can have serious effects on semiconductor devices (1), (2). Many have become involved with this problem, perhaps in the handling of microwave diodes or other semiconductor devices, and know that discharging a static charge through a semiconductor device may have any one of several effects. For instance, with microwave detector diodes, a static discharge may completely destroy the device, simply reduce the sensitivity of the diode, cause the diode to become intermittent, or have no apparent effect. The damage to the semiconductor device normally occurs in one or more of the p-n junctions shown in Fig. 1. Effects on microwave diodes have been mentioned not because they are the only types of device affected but because as a group they are probably the most sensitive to the effects of static charges. In fact, with the possible exception of large-power devices, all semiconductor devices may be damaged by static discharges (1). With other devices, again, as with the microwave diodes, the effects are not definite. For instance, a transistor which has had a static charge passed through it may show no apparent damage initially, but it may fail early in life. Second, the transistor may have a change in beta (gain) or some other parameter as a result of the static discharge but otherwise appear to be unaffected. Third, the transistor may fail completely when the static charge passes through it."

Electronics

ROBOT TRACTORS SUPPRESS STARTER INTERFERENCE

Electronics, August 22, 1966, has a news item under "Electronics Abroad" concerning an English Robot tractor. In the section titled "Problems" is a paragraph with the following item of interest:

"Problems. The toughest problem in developing the remote-control system was getting around the radio interference during start-up since current surges in the tractor's starter couldn't be suppressed. This was solved by delay circuits that transmit the start signal over a preset duration."

NEW USE FOR SUGAR GROVE, W. VA.

Electronics, August 22, 1966, under "Military Electronics", contains an article on the new use of the site at Sugar Grove, W. Va., prepared for the 600-foot diameter radio telescope. A paragraph of interest is as follows:

"The new station will serve as the Washington-area receiving point in the Navy's worldwide communications system as well as a link to the Defense Communication Agency's network. It will be operational in early 1969 and will replace a receiving facility in Cheltenham, Md., that the Navy says is being affected by electromagnetic interference as new houses are being built in the suburban areas. The Sugar Grove site is an ideal replacement because it is about 150 miles from Washington in an area nearly free from such interference."

GOVERNMENT AND INDUSTRY SEEK TO BLOCK INTERFERENCE

A 4-page article in Electronics, September 5, 1966, by Carl Moskowitz, Instrumentation Editor, describes the steps which various departments of the government are taking to overcome RFI. The sub-title and opening paragraphs are as follows:

"Radio-frequency interference is becoming more of a problem in communications as use of the electromagnetic spectrum expands.

"Soon after Christmas last year, many of the 900,000 or so radio operators who use the Citizens' band (27 megahertz) were horrified to find their adult business world invaded by a barrage of children's voices claiming to be cops, robbers, Indians and cowboys.

"The new transistorized walkie-talkies, operating on the same frequency as radio-equipped trucks and cabs and car telephones had hit the Christmas market, and were being operated by children across the country. Besides disturbing the Citizens'-band operators, the new toys interfered with television sets in some cities.

"Last December, when Frank Borman and James Lovell orbited the earth in Gemini 7, the tracking station at Corpus Christi, Texas, lost contact with the astronauts. It was soon discovered that the cause was radio-frequency interference from the motor of a crane in a nearby steelyard. Since the noise blocked most of the useful data from the spacecraft, the National Aeronautics and Space Administration halted the crane's operation until the mission ended.

"These cases of rfi are only two of many that take place in the increasingly crowded electromagnetic spectrum. But Citizens'-band operators and astronauts are not the only ones plagued by the problem. Perhaps more involved are the military services, the Federal Communications Commission, industry and research centers. 'There are serious implications to the problem,' states Major General Richard J. Meyer, Commanding General of the Army's Strategic Communications Command. 'Radio interference can be severe enough to result in the loss of some defense capability."

ELECTROMAGNETIC COMPATIBILITY REQUIREMENTS FOR SPACE SYSTEMS

C. B. Pearlston, Jr., Aerospace Corporation, El Segundo, Calif., has prepared a specification identified as TOR-1001 (2307) -4 under the above title. The first two paragraphs of the Scope are as follows:

> "This specification provides the requirements for electromagnetic compatibility (EMC) applicable to each launch vehicle, space vehicle. AGE and/or composite space system procured by the Space Systems Division (SSD), Air Force Systems Command (AFSC). An EMC program shall be instituted to implement these requirements from issuance of contractual go-ahead through the operational life of the affected system(s). This shall achieve a maximal confidence level and probability of specified system performance for each affected system in its operational environment.
>
> EMC Program
>
> "This specification shall be used by each contractor for the purposes of establishing and maintaining an EMC program. The EMC program shall be delineated in an Electro-Interference Control Plan in accordance with AFSCM 310-1, 5-7-14. 0. The application of such a program shall be made to the composite system its subsidiary systems including AGE, and their respective subsystems and equipment, according to the jurisdiction of each contractor. An EMC program for the various electromagnetic interfaces between contractors shall be coordinated by the contractor assigned integration responsibility by SSD. The affected contractors shall participate in the EMC Board (Para. 3. 1. 1. 1), in conjunction with the integration contractor, to facilitate the coordination of EMC interface activities and/or resolution of common EMC problems. The effective implementation of each EMC program shall be demonstrated by, and be reflected within, the applicable Electro-Interference Control (EIC) plan(s), with verifications through the applicable EIC Test Plans, Tests, and Test Reports. Each contractor must demonstrate EMC at his affected subsystem/system level in the specified operational environment (or acceptable simulation thereof)."

COMPOSITE MATERIALS ARE SELF-LUBRICATING

Bemol Inc., Box 11, Newton, Mass., has a page article, under the above title, in the August 1966 issue of Materials in Design Engineering. The sub-title and first paragraphs are as follows:

> "Twenty-five different compositions are available for electrical, high temperature and other bearing applications.
>
> "A unique materials concept in lubrication is to take a solid lubricant such as columbium selenide and combine it with a bearing metal such as silver or nickel. The new family of composite bearing materials are made by hot pressing in which simultaneous heating and compacting of the metal matrix and solid lubricant powders results in the formation of extremely dense, solid and essentially metallic, self-lubricating shapes.
>
> "An advantage of the hot pressed composites is that they have considerably greater strength and longer wear life than parts produced by conventional pressing and sintering. In addition, the hot pressed composites, unlike sintered materials, have uniform particle distribution throughout the matrix and are free of voids."

THE COMPUTER-INSTRUMENT INTERFACE

J. C. Rhodes, American Oil Company, has written a 5-page article under the above title in the September 1966 issue of Control Engineering. The sub-title and paragraphs of interest are as follows:

> "The hardware link between analog process transmitters and the digital computer has often been overdesigned because specifications for such factors as noise level and impedance are based on manufacturers' worst experiences. Computers demand carefully reasoned techniques for signal-conditioning, multiplexing, and conversion, but not elaborate ones.
>
> Noise reduction techniques
>
> "For successful computer control, the process information in the computer must be essentially noise-free. The many different forms of noise encountered include process noise, such as occurs with flowmeters on lines that contain pulsating pumps; 60-cycle ac noise; white electrical noise; and pulses or spikes.
>
> "Conventional twin-tee or low-pass filters usually reduce the 60-cycle and white electrical noise to a tolerable level. The filter time constant is about 0. 5 sec, which is adequate for almost all analog inputs. Only such high-speed analog signals as the input from a pneumatic scanner-transducer would require a faster response.
>
> "The 60-cycle noise can be further reduced by such techniques as the voltage-to-frequency converter mentioned above, with a pulse-counting interval of 1/60 sec. With successive approximation converters, 60-cycle noise can be eliminated by averaging two samples taken 1/120 sec apart.
>
> "Silicon controlled rectifiers introduce noise spikes on power lines, which can cause erratic readings by radiation to signal lines. The frequency varies from 200 kc to 2 Mc and the spikes can be as large as 20 or 30 volts on a 110-volt circuit. Tuned filters with inductance on the input to the SCR circuit eliminate such spikes or reduce them to an acceptable level.
>
> "Some sources of noise spikes, such as relay switches on large motors, are not practical to filter. The flying capacitance switching technique prevents such spikes from getting through to the converter. The preferred type of voltage-to-frequency converter discussed earlier is also insensitive to these spikes, which are usually of very short duration.
>
> "Most commonly, digital filtering eliminates erratic readings due to noise spikes. This is a programming technique, in which the computer compares successive readings of a scanned variable. Most process variables do not change value abruptly between scans. If the new scan disagrees with previous scans by a large amount, the computer calls for a rescan. If the rescan agrees with the earlier values, the suspected value is discarded. But if the rescan agrees with the reading in question, both values are averaged, and the variable is assumed to have changed to this new average value. The program may include other options such as a call for operator attention to the process transmitter involved.
>
> "Process noise generally exhibits much longer time constants than electrical noise, and is harder to filter mechanically or electrically. On pneumatic systems, and if response time is not a limiting factor, restrictive orifices placed in the signal lines can filter out process noise. Again, a programming technique is more common, where several scans are taken over a period of time and the readings are then averaged, sometimes with weighting factors as a function of time."

MEASURE POTENTIOMETER NOISE CORRECTLY

and you may find that your noise problem has disappeared - or at least eased.

Robert Jabs and Richard Boman, Bourns, Inc., Trimpot Div., Riverside, Calif., have a 5-page article, under the above title, in the July 19, 1966 issue of Electronic Design. The first paragraphs of interest are as follows:

> "Just as gardeners have to 'live with' some weeds, so must you, as an engineer, put up with a certain degree of noise in potentiometers. But if you are overly concerned with that degree, perhaps you are not taking into account all the necessary factors when measuring noise.
>
> "Better materials and manufacturing techniques have improved inherent noise figures to the point where they may no longer be significant in your design. With correct noise measurement, you may find that what you thought was a problem no longer exists, or that you have overdesigned.
>
> "In any analysis of the problem, it may help to consider first the sources of noise in precision and adjustment potentiometers, some of which are shown in the accompanying photographs.
>
> "It is interesting to observe that most potentiometers that are discarded are rejected because of noise at incoming inspection. Few rejects actually occur during use. One reason is that many users specify noise levels well above available minimums. These minimums have been accepted by many other users as standard. Cognizant of this problem, most manufacturers strive to reduce the noise level of all potentiometer types below the generally established standard for precision types. The result actually is some degree of overdesign.
>
> "Under definitions of the Military and Precision Potentiometers Association, the two most common ingredients of noise are its apparent random nature and the fact that it is a distortion of the desired voltage."

MINIATURIZED COMPONENTS FOR EMI SUPPRESSION IN PHOTO-OPTICAL CONTROL SYSTEMS

Arnold L. Albin and Edward I. Busch, Fairchild Space and Defense Systems, Syosset, L. I., New York 11791 authored a 7-page paper which appeared in the June/July 1966 issue of the Journal of the Society of Photo-Optical Instrumentation Engineers. The sub-title is as follows:

> "Camera control systems, stabilized mounts, navigational computers and related photo-optical control systems can produce high levels of electromagnetic interference from pulse circuits, switches and relays. In military applications such interference must be controlled carefully. This paper considers the problem in terms of current military specifications for measurement and acceptable limits. It covers methods of noise suppressions and describes the development of a postage-stamp size resistance capacitance filter for high attenuation of conducted and radiated interference."

Paragraph headings are as follows:

"Interference Generation and Suppression"

"Miniature Suppression Component Development"

"Effect of Suppression Networks on Relay Response"

"EMI Suppression Effectiveness"

"Applications"

"General Shielding Concepts"

"Selection of Metal and Determination Thickness"

"Seams and Joints"

"Openings for Meters, Jacks and Switches"

"Filters and Cable Shielding"

"Conductive Finishes"

Copies of this paper may be obtained from Mr. Arnold L. Albin at the above address.

EFFECTIVE ENHANCEMENT OF RECEIVER DYNAMIC RANGE

S. Perlow and B. Bossard, RCA Advanced Communications Laboratory, New York, New York, have a 4-page article, under the above title, in FREQUENCY, July-August 1966 issue. The sub-title and first paragraph are as follows:

> "Have you considered using feed-forward filter techniques to improve the interference rejection of your communications system? Perlow and Bossard did, and they came up with a method for achieving band rejection filters with equivalent unloaded Q's of 10,000 or more at frequencies as low as 1 MHz. What's more, you can make the filter a low-, high-, band-pass or band-reject type simply by varying one element, and achieve variable bandwidth and rapid tuning throughout wide frequency ranges. Here, to illustrate the technique, they describe a typical filter, tunable throughout the 50 to 100 MHz range, that is capable of rejecting a 45 db signal spaced 20 kHz from the desired 60 MHz signal, with an insertion loss to the desired signal of 1/2 db.
>
> "In considering the basic effect of external interference, we must remember that the band of interference frequencies to which the receiver is sensitive is much wider than its 'bandwidth'. The attenuation of frequencies outside the normal transmission band is never infinite, and there is often insufficient rejection of large interfering signals with frequencies well beyond the receiver's bandwidth. These strong interfering signals may produce one or more of three effects: they may be strong enough to be transmitted directly to the output despite further attenuation in succeeding selective stages, such as the IF stages of superheterodyne receivers; they may be strong enough to overload one or more stages, making the receiver inoperative; they may combine with other signals in a non-linear element to produce new frequencies within the receiver's bandpass."

New Products

Honeywell Brings Out New Filter

Honeywell, Box 391, Annapolis, Maryland 21404, has brought out a new high-pass filter to overcome a unique interference problem which was a problem of how to operate receiving equipment in close proximity to a Loran high-powered transmitter. The filter is called type FHP-2100 and will attenuate the 1950 kc Loran signals. Further information can be obtained by writing to the company at the above address.

Shepard Labs. Advertises New Low Cost, High Speed Line Printer

Shepard Laboratories, Inc., 480 Morris Ave., Summit, NJ 07901, has brought out a new low cost, high speed Line Printer, Shepard Model 400, which has an extremely low RFI factor. RFI has been drastically reduced by the following features:

Specially designed, high efficiency solenoids require less drive current. Electrical and magnetic interaction between the solenoids and their associated circuits is virtually eliminated.

A new design of the firing circuits associated with the solenoids reduces peak currents drawn from the power supply by a factor of more than 3 to 1.

Elimination of long lead lengths, and of high peak currents from the power supply, correspondingly reduce radiation of RF noise and interference.

Littelfuse Brings Out RF Interference Shielded Fuse Posts

Littelfuse, Des Plaines, Illinois, has brought out two RF Interference Shielded Fuse Posts which meet military and commercial applications. The two new waterproof (RF) Radio-Frequency shielded fuse extractor posts are designed to take 3AG and 8AG size fuses for use in such applications as military ground support test equipment and commercial and industrial computers. For miniature fuses, like Littelfuse's Microfuses, two RF shielded holders for front (Part #2820001) and rear (Part #2820002) panel mounting are also being made. They are ruggedly constructed to withstand environmental conditions such as salt spray, vibration, shock and water immersion.