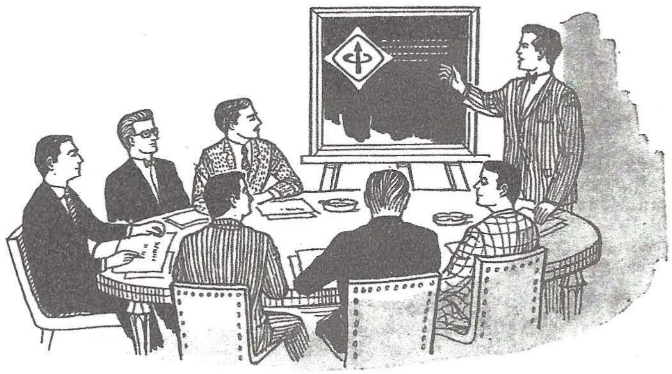
IEEE NEWSLETTER

ELECTROMAGNETIC COMPATIBILITY GROUP

ISSUE NO. 47

Rexford Daniels, Editor
Monument Street, Concord, Mass.

FEBRUARY 1967



Chapter Activities

Central Texas:

A meeting was held on June 29, 1966 and Messrs. Walter C. Dolle and W.E. Cory, Southwest Research Institute, San Antonio, Texas, spoke on "Measurement of Field Strength Attenuation in the Near Field".

Another meeting was held on October 6, 1966 and Mr. Robert C. Mecke, City Public Service Board, San Antonio, Texas, gave a talk on "Radio and Television Interference Problems on Distribution Circuits".

Chicago:

The following meetings have been held by this Chapter:

September 13, 1966 - Mr. John Walsh, Allis-Chalmers Mfg., Co., spoke on "Grounding of Electrical Systems".

October 11, 1966 - Mr. Carl Jesperson, IITRI, gave a talk on "Theory of EMI Measurements in Shielded Enclosures".

November 10, 1966 - Mr. W. Ackerman, Motorola, Inc., spoke on "Radio Systems Degradation, Cause and Effect".

Mohawk Valley:

On October 27, 1966 a meeting was held and a talk was given by Mr. Kenneth G. Heisler, Jansky & Bailey Engineering Dept., Atlantic Research Corporation, Alexandria, Va., on "Tropocal Radio Propagation Research Program".

New Orleans:

A Meeting was held on October 26, 1966 and Mr. Marvin E. Thames, Delgado College, New Orleans, spoke on "Engineering Education at Delgado College".

Philadelphia:

Two Meetings have been held by this Chapter: One on October 4, 1966 and a talk was given on "Instrumentation Techniques in EMC Measurements" by Dr. O.M. Salati, University of Pennsylvania, Philadelphia, Penna.; and a second meeting was held on December 7, 1966 and Mr. G.J. Palladino, American Electronic Labs., Inc., Colmar, Pa. spoke on "Design and Application of a Solid-State Impulse Generator".

Seattle:

There was a meeting held on September 28, 1966 and Mr. Richard Dickhaut, The Boeing Company, Seattle Washington, spoke on "Transient Radiation Effects on Electronics".

Another meeting was held on November 30, 1966 and a talk was given on "Simply Optimized Shielding" by Mr. Robert B. Cowdell, Genistron, Inc., Los Angeles, California.

Washington, D. C.:

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

Another meeting was held on November 10, 1966 and a talk was given on 'A Forward Look at Electromagnetic Compatibility Research & Developemnt" by Mr. John J. Egli, Director Electromagnetic Environment Division, United States Army Electronics Command, Fort Monmouth, N. J.

People

MEMBERS OF EMC GROUP ELECTED TO IEEE FELLOW AWARD

The following members of the EMC Group have been elected to receive the IEEE Fellow Award as of January 1, 1967:

John J. Egli
78 Clearview Drive
New Shrewsbury, N. J. 07719

Joseph L. Ryerson
Adriaan Goekooplaan 65
The Hague, Netherlands

John W. Findlay
National Radio Astronomy Obs.
Edgemont Dairy Road
Charlottesville, Va. 22980

Heinz M. Schlicke
8220 North Poplar Drive
Milwaukee, Wisconsin 53217

Leroy U.C. Kelling
1909 Forest Drive
Waynesboro, Va. 22980

The awards will be presented at the IEEE Convention March 20-23, 1967.

FRED NICHOLS LEAVES GENISTRON

Fred J. Nichols, a member of the Administrative Committee of G-EMC, has resigned as president of Genistron Div., Genisco Technology Corporation, Los Angeles, California, and plans to travel throughout the United States and attend the IEEE Show, in New York, the week of March 20th, 1967. Mr. Nichols has asked your editor to thank the EMC profession for the numerous things that helped make Genistron successful. His future plans are still uncertain but he intends to remain active in the EMC field.

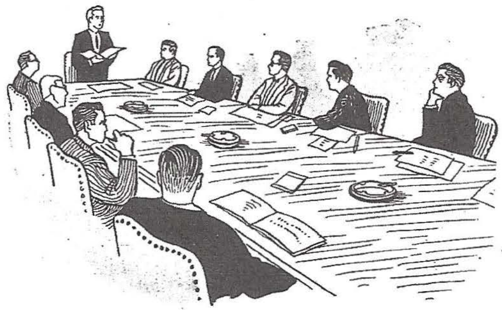
W.D. MC KERCHAR AWARDED SAE CERTIFICATE OF APPRECIATION

Walter D. McKerchar, McDonnell Aricraft Company, St. Louis, Mo., was awarded the Certificate of Appreciatio on January 12, 1967 for his outstanding contribution t the work of the SAE Committee AE-4, Electromagnetic Compatibility.

ADMINISTRATIVE COMMITTEE MEETINGS OF G-EMC

An AdCom meeting will be held during the IEEE Convention in New York, 20 March, 1:30 - 5:30 P.M., Room 513, New York Hilton Hotel.

A second AdCom meeting will be held during the 1967 EMC Symposium, Shoreham Hotel, July 18, in the evening. Exact time and room will be given later.



Symposiums

ELECTROMAGNETIC COMPATIBILITY GROUP PLANS 1967 SYMPOSIUM IN WASHINGTON, D. C.

Plans are shaping up for the 1967 Symposium on Electromagnetic Compatibility in Washington at the Shoreham Hotel. A committee under the guidance of Ralph L. Clark (F) will handle all of the arrangements for the meeting scheduled for July 18, 19, 20, 1967.

The theme of the meeting, Education, Measurement and Conservation, accents three inportant aspects of electromagnetic compatibility. Education will be fulfilled with tutorial sessions while other sessions will explore measurements and the conservation of the electromagnetic spectrum. The technical program is under the direction of Frank T. Mitchell, Jr. Scheduling of the technical sessions will be coordinated with a program of classified sessions on electromagnetic compatibility planned by the Department of Defense.

The symposium will include a display area for exhibits. Space arrangements may be made with F. Stad Marshall, Chairman of the Exhibits Committee.

For additional information, call James. S. Hill, Publicity Chairman, at 301-345-8900, or write to P.O. Box 7405, Benjamin Franklin Station, Washington, D. C. 20044.

SOUTHEAST EMC SYMPOSIUM IN HUNTSVILLE, ALABAMA

The Southeast Electromagnetic Compatibility Symposium will be held on May 24-25, 1967 at the Sheraton Inn in Huntsville, Alabama. The Huntsville Chapter of the IEEE Electromagnetic Compatibility Sub-Group is host to the Symposium.

The Symposium will feature the presentation of 10-15 papers based upon the theme of "An Engineering-Management Challenge." Local representatives will **display** current and new equipment peculiar to and affecting the field of electromagnetic compatibility.

There are no fees for attendance, however, all attending are expected to attend the joint G-27 IEEE Section dinner scheduled for the evening of May 24, 1967

Accommodation reservations should be made directly to The Sheraton Inn, 4404 University Drive, Huntsville, Alabama, Phone (205) 837-3250.

Symposium attendance and requests for further information should be forwarded to:

Everett T. Raylman, Symposium Publicity Chairman
Federal Electric Corporation
802 Shoney Drive
Huntsville, Alabama 35801

Editor's Note

The newsletter, starting with this issue, will begin to carry information on the problems presented by electromagnetic energy in other disciplines. It is hoped that the members of G-EMC will work through the new Spectrum Study Committee to bring to the attention of the other members of our Group pertinent information which they have found in other disciplines. If there are any members who would like to become continuingly active in this new field, will they please read the news item on the formation of the Spectrum Study Committee and write the chairman as to which discipline they would like to follow.

Rexford Daniels, Editor
Monument Street
Concord, Mass. 01742

TECKNIT AND R.F.I. CORPORATION JOIN TO FORM WESTERN EMI/RFI SHIELDING PRODUCTS SOURCE

In a joint statement, Stewart Nellis, President of Technical Wire Products, Inc., and E.F. Riggs, President of R.F.I. Corporation, announced the formation of Tecknit-Western Division to be located in Santa Barbara, California, with operations begining December 1, 1966.

The new Tecknit-Western Division will offer Western manufacturers the full line of EMI/RFI Shielding Products formerly manufactured by each company. Full manufacturing and engineering services will now be available to western O.E.M.

Tecknit-Western Division will be headed by "Woody" Riggs, and is located at 427 Olive Street in Santa Barbara, the former R.F.I. Corporation plant.

The new division will be represented by Tecknit's representatives El-Com Sales Company of Los Angeles for Southern California; James S, Heaton Company of Menlo Park for Northern Calfiornia; Bruce Kinkner & Associates of Phoenix for Arizona and New Mexico and Rep's Inc. of Salt Lake City for Utah, Idaho, Colorado and Montana.

G-EMC INVITED TO PARTICIPATE IN CONFERENCE ON COMMUNICATIONS

The Communications Technology Group of the IEEE is organizing its Third Conference on Communications which will be held in Minneapolis, Minnesota, on June 12-14, 1967. Papers are solicited dealing with various aspects of communications: telemetering information theory, compatibility, microwave theory and techniques, etc. Although a specific theme has not been announced, Dr. Collins, the technical program chairman, has stated that the Conference will be directed toward "The Demands of Data Transmission Between Computing Systems on Communications Systems."

G-EMC members who are concerned with EMC problems of data transmission are particularly invited to submit papers to this Conference.

Although the summary for papers had a deadline of December 1st, 1966, information may be obtained from the Technical Program Chairman, Dr. R.J. Collins, Department of Electrical Engineers, University of Minnesota, Minneapolis, Minnesota 55455.

IEEE TC-27 MERGED WITH G-EMC

The IEEE Technical Committee 27 on EMC has been merged with the Group on Electromagnetic Compatibility and will now be known as the EMC Standards Committee of G-EMC. Chairman of the EMC Standards Committee is John F. Chappell.

G-EMC FORMS SPECTRUM STUDY COMMITTEE

A new G-EMC Committee has been authorized by our chairman, A.H. Sullivan, Jr., and is to be known as the "Spectrum Study Committee" with Rexford Daniels, your editor, as chairman. The purpose of this new committee is to provide an information integration center for the side effects of electromagnetic energy which are taking place throughout the entire spectrum in an increasing number of disciplines. The need for such a committee evolved from the inputs to the study being conducted by the Joint Technical Advisory Committee for the Director of Telecommunications Management to the President on the utilization of the spectrum. Your editor is chairman of Subcommittee 63.1.4 on Side Effects of Electromagnetic Energy and has been swamped with technical information from all sources. A function of this committee will be to provide pertinent information of interest to the EMC Group which will appear in a new section of the G-EMC Transactions. Members who would like to join this committee with the intention of taking active part in following through on developments of interest in other disciplines will please send in their name to the chairman and a description of the discipline which they would like to keep in touch with . G-EMC has been missing a good many bets because there has been nobody assigned to follow them up. It is hoped to remedy this situation through the activities of this committee.

PANEL SESSION ON "EMC IN SYSTEM DESIGN"

A Panel Session is scheduled for March 20, 1967 at the IEEE International Convention, in New York, N.Y., at 9:30 A.M. The topic will be "Electromagnetic Compatibility in System Design" and the speakers will be:

Dr. Jona Cohen, Motorola, Inc. on Land-Mobile Systems

Mr. John Roman, Dept. of Navy, on Militray Communications

Mr. Ross Evans, NASA, Huntsville, on Areospace

Mr. Walter McKerchar, McDonnell Aricraft, on Aerospace

8TH SYMPOSIUM DIGEST AVAILABLE THROUGH IEEE HEADQUARTERS

The Digest for the 8th Symposium on Electromagnetic Compatibility, held San Francisco July 11-13, 1966, is now available through the IEEE Headquarters. Inquiries shoul be made to the Publication Sales Department. The price for the Digest is $5.00.

books

Noise And Its Effect On Communications. by Nelson M. Blachman, Ph.D., Senior Scientist, Sylvania Electronic Systems, Mountain View, California. 205 pages, plus 7 page index; 40 illustrations; 6 x 9; McGraw-Hill Book Co., 330 West 42nd St., New York, N.Y. 10036. $13.50.

"This is a concise, unified treatment of the useful fundamentals of random processes and their spectra, the effect of nonlinear transformations upon signal and noise, the statistical theory of detection, and information theory.

"The first part of the book, consisting of four chapters, covers the statistical properties of noise and random signals and included discussions of the univariate, bivariate, and multivariate normal (gaussian) distributions, their moments, and related probability distributions; random processes, with special attention to those that are ergodic; power spectra; and the statistics of narrowband signals and noise. Part 2 deals with the effect of noise upon signals in various nonlinear devices, such as AM and FM demodulators, limiters, harmonic generators, and unintended nonlinearities. The output signal and noise determined on the probability of error in the detection of coherent, incoherent, and noise-like signals. The fundamentals of information theory are present in Part 3."

A Handbook on Methods and Procedures for Automating RFI/EMI Measurements

White Electromagnetics, Inc., 670 Lofstrand Lane, Rockville, Maryland, has published a 200 page book under the above title. The cost of the book is $15.00. Excerpts from the preface are as follows:

"It is contractually, competitively, and economically imperative to become knowledgeable about automated electromagnetic interference (RMI) test instrumentation and measurement techniques. It follows that the organizing, planning, and scheduling of a company's EMI activities and programs by the EMI engineer or his supervisor must now be significantly reoriented. This comes about as a result of the fact that interference or emission test time is compressed to the order of one-one hundredth of what it used to be in the manual-test ear by the introduction of fully automated test instrumentation systems. Overall costs to perform spectrum test measurements are now of the order of one-tenth of those corresponding to manual instrumentation and assiciated test methods. Thus, it is paramount for responsible EMI personnel in each organization to learn the impact of EMI automation on the R&D cycle, production phase, retrofix, and installation and checkout phase before preparing and submitting control and test plans.

"The finest instruments in the world are of little value if used either by inexperienced operators, or if the missions, associated data presentation, or system parameters are not identified or adequately defined. Historically, EMI testing has the reputation of being of questionabe merit, since established test methods and procedures have left much to the imagination of the operator. This situation is aggravated by the surrounding physics which often play a dominant role in the outcome of tests. Additionally the ambient environment may substantially affect repeatability of data. Recognizing, then, the inserparable role of instruments, their environment, and the methods of their use, this handbook sets forth test methods and procedures for automating RFI/EMI measurements.

"The first chapter of this volume introduces the subject of RFI/EMI measurements, specification control and test plans, including the impact of automation, EMI ambient environments, and automatic and semiautomatic instruments. It concludes with definitions of pertinent instrumentation and measurement terms. The second chapter sets forth procedures for calibrating automatic and semiautomatic instruments. The next two chapters describe the steps required to perform interference or emmission tests of both conducted and radiated types. The final two chapters review conducted and radiated susceptibility testing.

"The appendices cover a number of pertinent background subjects including the Automatic Spectrum Display and Signal Recognition System, the Auto-Plot Controller, sign readout and identification, calibration details, and various conversion charts. A comprehensive index is locat at the end of this handbook, and a list of abbreviations and symbols appears just before chapter 1.

"Prime emphasis in this volume is placed on applicatio fulfilling MIL-STD-826 tests. These procedures will be directly applicable to MIL-STD-462 when it becomes effective. Many of the EMI test procedures are useful on othe EMI specifications such as MIL-I-6181D, MIL-I-16910C, MIL-I-11748B, and NASA -SPEC-279. One of the appendices covers some specification differences, such as antenna correction factors, for determining antenna-induced voltage rather than field intensity.

"This handbook is the first of six volumes of a series on the applications and test methods associated with automatic spectrum scanning and recording instruments...."

The When Why and How of Magnetic Shielding

Westinghouse Electric Corporation, Westinghouse Metals Division, Blairsville, Penna. 15717, has published a Designers Handbook of 34 pages under the above title. Paragraphs of interest from the Introduction and chapter titles are as follows;

"A. Introduction

"Operation of even the best-engineered circuits can be serioulsy impaired by magnetic interference from nearby components or (in very low-level applications) from the earth's magnetic field. For example, the magnetic field generated by the driving motor of a tape recorder can completely dominate the signal unless the heads are protected. The electron beam of a cathode ray tube will be deflected by the field of a transformer used in the circuit. Input transformers handling low-level signals must be protected from spurious fields.

"Stray magnetic fields are a major problem in situations involving low impedance and low frequency. Typical sources of magnetic interference are:

"1. Permanent magnets or electromagnets
"2. Cables carrying large direct currents or high altering currents at power frequencies
"3. AC or dc motors and generators
"4. Solenoids, reactors, transformers, or other coils

"A familiar example of magnetic interference is '60-cycle hum' - the leakage of power-frequency energy into the audio circuits of amplifiers. Again a radar monitor system may require a CRT and an electric motor in the same cabinet. Because interference from the monitor can deflect the electron beam in the CRT, the interfering field must be reduced to a minimum.

"This attenuation can be accomplished by physical separation or by shielding. The magnetic field intensity at any point is inversely proportional to the cube of the distance between that point and the field source, so physical separation can contribute sigificantly to reducing interference. Sensitive components (such as CRT's) will also require shields."

Chapter I - What Is Shielding?

Chapter II - Choosing The Shield Material

Chapter III - Cylinderical Shield Design

Chapter IV - Conical Shield Design

Chapter V - Multiple (Nested) Shields

Chapter VI - Wrap Around Shields

Chapter VII - Evaluating Shield Performance

Chapter VIII - Heat Treatment After Fabrication

The cost of the handbook is $1.00

Research Reports

The following reports may be obtained from: Clearinghouse, U.S. Dept. of Commerce, Springfield, Va. 22151. The first price is for conventional and the second price for microfilm copies. Checks should be made payable to: National Bureau of Standards CFSTI. Qualified Defense Documentation Center users can order "AD" reports cost on DDC Form 1, from the Defense Documentation Center, Cameron Station, Alexandria, Va. 22314.

Study of Noise in Semiconductor Devices. - Experimental and theoretical investigations of noise in micorwave transistors, MOS and junction FETs, PIN diodes, laser diodes, etc. are reported. Emphasis is on noise properties of microwave transistors. Minn. Univ. 636-324, $4/$0.75.

A New Type of Broadband Low-Noise RF Amplifier. - Details are given for a phase-shift paramp with less than 1 dB NF at 270 K, broad bandwidth, and other improvements over conventional parametric amplifiers. U.S.A.E.C. AD 634-663, $1.00/$0.50.

Notes on Articles of Interest

LIMITING FACTORS IN THE PULSER-DUT-SCOPE SITUATION

Electronic Products, November 1966, carries a 2-page article by Thad Dreher, E-H Research Laboratories, Inc., Okland, Calif., under the above title. The sub-title and first paragraph are as follows:

"Nanosecond measurements are tricky, Here's how to analyze your test setup and avoid problems before they start.

"Response time of many devices is rapidly becoming comparable to that of available time-domain instrumentation. Fast state-of-the-art devices, memory elements, logic elements, transformers and transmission lines now require testing in the nanosecond and subnanosecond regions. Making meaningful measurements at these speeds requires careful analysis of each element of the test setup."

HANDLE SENSITIVE MEASUREMENTS WITH AN ELECTROMETER

Electronic Products, November 1966, carries an article with 7 figures by John R. Yeager, Asst. Vice-President, Engineering, Keithley Instruments, Inc., under the above title. The sub-title and paragraphs of interest are as follows:

"Here's how you can read the output of high-impedance sources, picoamp currents and extremely high resistance.

"Electrometer amplifiers have distinctive characteristics. They have input inpedances, low current offsets, and dc to low-frequency ac amplification. While there are many kinds of electrometer amplifiers, those that have electrometer tube inputs offer the best compromise of input impedance, low current offset, frequency response, immunity to overvoltages, durability and cost. Using these amplifiers, voltages from extermely high impedance sources, currents in the picoampere region, charge and very high resistances can be accurately measured.

Electrometer Hazards

"Grounding, shielding and guarding are other factors that can determine the success or failure of an electrometer measurement. Ground loops between equipment can occur when an instrument, grounded through the power line, is connected to a sorce that is also grounded through the power line. This ground current must flow through the common connection between the source and the instrument input. It can impress enough ac on the instrument amplifier to saturate it and thus cause a dc offset. This offset, when interpreted as an input signal, is certain to cause erroneous readings.

"Guarding input connections to electrometer instruments decreases response times and reduces errors due to leakage resistance between the input and a nearby point at a different potential. In resistance measurements, guarding facilities measuring higher resistances than that of the input insulation.

"In general, a guard is a conductor spaced between the high and low terminals of an instrument and driven by a low-impedance source to the same potential as the high terminal. It effectively reduces the slowing effect of capacitance between the high and low terminals in current, voltage and resistance measurements. A picoammeter combined with a power supply to make high resistance measurements using the low terminal of the picoammeter as a guard is shown in Fig. 6.

'Without the guard, R_L would be between the input and the grounded side of the power supply. It would be measured in parallel with unknown R_x. With the guard, resistance as high as 10^{14} ohms. A guarded connection for measuring resistance using the Keithley Model 610B Multipurpose Electrometer is shown in Fig. 7. When using this instrument, the guard terminal is actually the low terminal and the low terminal or ground side of the input connection becomes the guard. This allows a conventional coaxial input cable and connector to be used, with the outer braid becoming the guard around the high terminal."

FLAT CABLE

Walter J. Prise, Lockheed Missiles & Space Company, Sunnyvale, California, has written a state-of-the-art-review under the above title in the December, 1966. issue of Electronic Packaging and Production. A section of interest is as follows:

Shielding Flat Conductor Cables

"In many applications the harness must be shielded against electromagnetic and electro-static interference.. These may originate from outside sources or from internal signals carried in individual conductors which may cause disturbances in the adjacent wires and components. Shielding patterns of the flat cables are different from those used in round wires; for instance, twisted wires cannot be duplicated in flat circuitry without involvement of complex interconnecting techniques which hardly justify the effort and expense.

"With regard to shielding, the most common materials used with flat cables are solid foils of various thicknesses, perforated metals, and wire mesh. The latter two arrangements were introduced for reduction of weight and improvement of flexibility of flat conductor cables over solid shielding, although they naturally reduce overall shielding effectiveness. Additional isolation can be obtained by grounding the conductors adjacent to the one for which shielding is desired. Similarly, silver epoxy and sprayed-on metallized coatings can also provide some shielding, while at the same time leaving the basic circuit's flexibility virtually unchanged.

"From results of available test data, the following conclusions on relative effectiveness of shielding can be made for a range of frequencies from 250 kHz to 25 mHz (round and flat cables were placed in the vicinity of a radiating probe): Flat cables pick up less interference voltage than round wires, particularly on circuits containing high impedance. However, the currents induced in the flat conductor leads were higher than those induced in round wires; this phenomenon was particularly emphasized in low-impedance circuits.

"Cross Talk between two conductors is defined as a current developed in an adjacent circuit when signal voltage is sent through a conductor. To find the captive reactance of the circuit, voltage is divided by the current configuration of the flat conductor cables.

"With respect to flat printed circuitry, one disadvantage in all applications requiring shielding, because the physical configuration is fixed, the circuit's electro-magnetic and electro-static interference characteristics do not change from unit to unit. Once the shielding problems have been solved, the find tuning of each circuit is greatly simplified."

NOISE IN LOW-LEVEL CIRCUITS

Electromechanical Design, November 1966, carries a write-up, under the above title, as follows:

"Demands for more accurate low-level instrumentation systems have led to new developments which now permit the engineer to design low-level, wide band data systems which will be virtually moise-free, down to and including the microvolt region. David H. Nalle of the Clevite Corp., identifies the major sources of low-level electrical noise and describes how each can be eliminated or reduced to acceptable levels in his paper, Elimination of Noise in Low-Level Circuits. He describes and illustrates signal source impedance, proper grounding procedures, system wiring techniques, choice of signal cables, signal conditioning and amplifier selection. In conclusion, the author emphasizes important points:

"Select signal sources that have a low output impedance, a center tap on the output and provide a clean noise-free output.

"Use only top quality signal cable in which the signal pair is transposed or twisted at regular intervals and protected with a lapped foil shield plus a low resistance drain wire.

"Provide a good low resistance static or system ground plus a stable ground located near the signal source.

Purchase good differential amplifiers for all low-level circuits which have a high impedance floating input and a 60c/s common mode rejection of 120 db or better

"Ground signal cable shield and signal cable circuit only at the signal source and make sure that neither of them contact ground either deliberately or accidentally at any other point.

"Use the differential amplifier guard shield to extend the internal shield of the amplifier out to and including the signal source."

DESIGNING FLANGES AND SEALS FOR LOW EMI

Steven Galagan, Consultant, Parker Seal Co., Culver City, Calif., has a 4-page article, under the above title, with 8 figures in the December, 1966, issue of Microwaves. The sub-head and first three paragraphs are as follows:

"A method for determining bolt spacing on a waveguide flange for predetermined pressure between bolts. Also, how to compensate for incorrect flange design by contouring the seal.

"Electrical breakdown of waveguide flanges is common at high power levels. Leakage from waveguide and EMI seals also occurs frequently.

"Studies reveal that flange bolts are often positioned so that the pressure over the flange area is not uniform even when the bolts are torqued equally. This article develops a technique for determining the proper location of bolts for uniformity of applied force over the flange. It also tells how to contour seals to compensate for improper bolt spacing.

"For analysis, an electrical seal may be considered elastic and sandwiched between two inelastic but flexible falnges as shown in Fig. 1. This is a generally correct assumption of the modulus of elasticity of the seal is less than that of the flanges. The analysis also holds true when all members are made of the same material, and when they are both flexible and elastic. But for clarity and ease of understanding, all of the bending will be assumed to take place in the flanges, with only the seal considered to act as an elastic member."

ARTICLES OF INTEREST IN ELECTRONICS, OCTOBER 31, 1966

Tiny Filters Block the Path of Radio-Frequency Interference

Peter A. Denes and John J. Crittenden, Denesco, Inc., Albuquerque, N.M., have co-authored a 10-page article under the above title. The subtitle and paragraphs of interest are as follows:

"New materials and design techniques have created improved devices to combat the problem of interfering signals.

"The small size, greater power and increased complexity and sensitivity of modern electronic systems have greatly increased the possibility of radio-frequency interference. However, reliability requirements have become more stringent too, demanding elimination of even the remotest chance of unwanted signals.

"To combat rfi, smaller and more effective low-pass filters have been developed. They allow dc and low-frequency power signals to pass but sharply attenuate signals at radio frequencies from about 100 kilohertz to 10 gigahertz. Work on filters was spurred by the limitations of simple commercial bypass capacitors.

"The low-pass filters are built with lossy inductive elements - iron powder or magnetic-alloy dust cores - fitted into capacitors made of ceramics with high dielectric constants. Because they are lossy they have better attenuation characteristics at high frequencies where the external circuit may resonate with the filter's elements. As the diagram on page 64 indicates, the inductors usually consist of a single conductor - which can be a connector pin - passing through a tube of magnetic material. The capacitors are formed around the indicator by bonding thin metal plates on the inside and outside surfaces of a ceramic cylinder.

"Because the ceramics have high dielectric constants, the capacitors are very small and so are the filters. A typical filter, in the photograph at the left, is only about 3/16 inch in diameter and 0.47- inch long. Nevertheless it can attenuate rfi signals by at least 65 db at 200 megahertz and 80 db from 1,000 to 10,000 Mhz. A filter can be mounted on a shielded compartment and used to conduct filament currents to high amperage circuits in the compartment. At the same time it prevents rfi signals from getting in or out of the compartment."

Correlation Entering New Fields With Real-Time Signal Analysis

Bernard LuBow, Princeton Applied Research Corp., Princeton, N.J., has authored a 7-page article with numerous illustrations under the above title. The sub-title and paragraphs of interest are as follows:

"From probing for a brain tumor to exploring for oil, autocorrelation and crosscorrelation are proving invaluable when noise must be filtered from very low level signals.

"Correlation analysis - the powerful but formerly time-consuming technique for analyzing signals and systems behavior in communications and radar - is leaving the laboratory and is heading to the field and operating room. Recently developed instruments and methods that permit autocorrelation and crosscorrelation to be measured on-line and displayed in real time are opening new avenues for the process and improving old ones. Correlation is being extended into radio astronomy, fluid and solid-state physics, neurology, seismology and other areas.

"The expansion of correlation analysis is the result of increased exploration of phenomena that have very low level signals - brain waves and stellar radiation for example. Digging a signal out of noise is the major function of analyzing data in both geophysical exploration and underwater detection. These signals are often hidde beneath a blanket of similar signals and extraneous nois to separate the signal from the noise, instruments of unprecedented accuracy and sensitivity are needed. Hence scientists often resort to correlation analysis to find these obscure signals. But previously this meant expens specially designed equipment for each specific situatio Worse yet, old methods and equipment couldn't operate in real time and were primarily limited to low-frequency applications.

"The situation is changing, however. New efficient instruments can continuously sample even the most noisy signals and compute the correlation function simultaneously- permitting the function to be observed almost immediately and continuously."

LOW-FREQUENCY NOISE PREDICTS WHEN A TRANSISTOR WILL FAIL

Albert van der Ziel and Hu Tong, University of Minnesota Minneapolis, have authored a 3-page article in Electronics, November 28, 1966, under the above title. The subtitle and first three paragraphs are as follows:

"Improved reliability studies may result from the use of noise measurements instead of statistical values to forecast the lifetime of the device.

"A new method for predicting the life expectancy of a transistor - based on measuring the device's noise at 1,000 hertz - could make transistor reliability studies simple and more accurate. Our preliminary work for the U.S. Army Electronics Command shows that transistor nois serves as an indicator of when the device will fail beca this parameter changes drastically toward the end of the transistor's life.

"Transistor noise at frequencies higher than 1,000 hz are not good indicators of the transistor's condition. This noise is produced by shot noise currents flowing across the transistor junctions and by thermal noise of the series resistances, mostly of the base resistance. (Shot noise is caused by random variations in the number and velocity of electrons and thermal noise by the thermal agitation of the electrons in the semiconductor.) Although these noise sources change with age during a transistor's operating life, they do so in the same manne as the currents and h-parameters, therefore limiting thei usefulness as an independent indicator of the impending failure of the transistor."

RATING SHIELDS

Electronics, December 26, 1966 contains an abstract of a paper presented by George A. Long, Rome Air Development Center, N.Y., at the 15th Annual Wire and Cable Symposium Atlantic City, December 7th-9th. The sub-head and first paragraph are as follows:

"A method of determining the comparative shielding effectiveness of cables, duct and conduit.

"Shielding qualities of ducting, conduit and coaxial cable can be compared by converting the ducting or condui into an equivalent of the coax. A center conductor is positioned in the duct or conduit and it is subsituated for the cable in the test setup. The measurements made on a standard type of cable are the basis for comparison.

Copies of the paper may be obtained by writing to Mr. Long at:

RADC (EMCVI-2/G. Long)
Griffiss AFB NY 13440

Science

ITEMS OF INTEREST FROM SCIENCE 25 NOVEMBER, 1966

Radar Observations of Insects in Free Flight

A 6-page article, under the above title, has been authored by Kenneth M. Glover, Kenneth R. Hardy, Thomas G. Konrad, W.N. Sullivan and A.S. Michaels. The subtitle and first two paragraphs are as follows:

"Radar tracking of single insects in the atmosphere leads to detection of distinctive phenomena.

"There has long been disagreement over the nature of many of the so-called 'angel' echoes which are commonly observed by radar from regions of apparently clear atmosphere (1). Birds, insects, and atmospheric refractivity perturbations are usually mentioned as sources of these echoes; however, the relative importance of one source in a given series of measurements is clouded by the almost total lack of quantitative measurements of radar backscatter for either known insect flights or refractivity perturbations. The object of the experiments discussed here was to extend our basic knowledge of the radar backscattering properties of insects in free flight and knowledge of the characteristics of these flights, in order to distinguish echoes from insects from those due to clear air phenomena.

"A number of cooperative experiments were performed during the summer of 1965 by the Air Force Cambridge Research Laboratories, the Applied Physics Laboratory of Johns Hopkins University, and the Entomology Research Division of the U.S. Department of Agriculture. This article presents the results of these quantitative observations of single insects in free flight, made with the ultrasensitive radars of the Joint Air Force-NASA (JAFNA) multiwavelength radar facility at Wallops Island, Virginia."

X-ray Detection by the Olfactory System: Ozone as a Masking Odorant

Edgar L. Gasteiger and Sharon A. Helling, Department of Physical Biology, New York State Veterinary College, Cornell University, Ithaca 14850, have authored a 3-page letter under the above title. The abstract and first three paragraphs are as follows:

"Abstract. The technique of masking was used to test the hypothesis that x-ray detection is mediated by an ordorant produced in irradiated air. Rats conditioned to cease licking during exposure to x-ray (conditioned supression) did not display this conditioned response in the presence of ozone and strong volatile oxidants.

"A role has been established for the olfactory system in the detection of low doses of x-ray by rats. Odorants, the olfactory membrane, nerve and bulb have been considered (1) among possible mediators of this effect. The discovery that alcohol on the nasal mucosa blocks x-ray activation of olfactory neurons (2) led to the hypothesis that detection is mediated by the production of odorants within the nasal passage or by direct action of radiation on the olfactory sensory cell.

"Because x-ray is known to produce active molecules such as ozone and oxides of nitrogen (3), we first undertook to eliminate gaseous odorants as possible causes of x-ray detection. On the assumption that an ordorant, such as ozone, is produced and signals the presence of x-rays, the ability of rats to detect x-ray in the presence of various levels of this gas was tested. The results strongly support the hypothesis.

"Twenty-three male Sprague-Dawley rats that weighed 250 to 300 g at the begining of the experiment were shaped over a period of 3 to 7 days in a Skinner box to lick for sweetened water after 23 hours of daily water deprivation. The Skinner box was a sound-insulated chamber (51 by 34 1/2 by 28 cm) which was provided with a speaker for delivering masking noise. When uniform rates of licking were reached. x-irradiation sessions were begun."

Light Stimulated Electrical Responses from Skin

Heywood Eric Becker, Dept. of Biology, Yale University, New Haven, Conn. 06520, and Richard A. Cone, Biological Laboratories, Harvard University, Cambridge, Mass. 02138, have authored a 2-page letter under the above title. The abstract is as follows:

"Abstract. When skin is exposed to an intense flash of light, an early electrical response can be detected from its surface. The signals that occur during the first milliseconds after the flash are similar to electrical signals recently observed in the eye from the cell layers containing melanin. Possibly the melanin in skin augments, but does not directly generate, this early electrical response. In addition, a late response, which arises hundreds of milliseconds after the flash, also occurs in skin. Unlike the early response, the late response is sensitive only to violet and shorter wavelengths of light and hence is probably mediated by a pigment other than melanin."

LOW NOISE, INTERFERENCE-RESISTANCE AMPLIFIER SUITABLE FOR BIOLOGICAL SIGNALS

SCIENCE, December 2, 1966, contains a report with two illustrations by Graham Schuler, Gordon Park Radio and Electrical Engineering Division, National Research Council, Ottawa, Canada, and John P. Ertle, Faculty of Psycology, University of Ottawa, Canada. The Abstract and first paragraph are as follows:

"Abstract. Minor changes in conventional low-noise amplifier circuits decrease circuit noise and attenuate the unwanted effects of varying impedances and potentials which exist between commonly employed electrodes and the tissues of biological subjects. The resulting reduction of intrinsic amplifier noise and reduced susceptibility to external interference is helpful in the study of low-frequency signals of microvolt level.

"The study of low-voltage biological signals is complicated by the impedances and potentials which exist between the electrodes and the biological subject. Extracellular potentials of electrically active tissues are frequently recorded at micro volt level from metallic electrodes inserted within tissue masses or applied to convenient surfaces. Between each electrode and the subject, there commonly exists an impedance to electrical current in the range of 500 to 10,000 ohms, and a chemically induced direct-current offset potential in the range of 0.1 to 100 mv."

"WHICH SHIELDING MATERIAL -- AND WHY"

A.W. DiMarzio, Aerospace Systems Div., Radio Corporation of America, Burlington, Mass., has an 8-page article, under the above title, in the October 1966 issue of EDN. The article contains 11 graphs. The titles of the graphs are as follows:

- Absorption Loss for Copper
- Absorption Loss for Aluminum
- Absorption Loss for "Mu-Metal"
- Degradation in Shielding Effectiveness Due to Low Absorption Loss
- Far-Field Reflection Loss
- Electric Near-Field Reflection Loss for Copper
- Electric Near-Field Reflection Loss for Aluminum
- Electric Near-Field Reflection Loss for "Mu-Metal"
- Magnetic Near-Field Reflection Loss for Copper
- Magnetic Near-Field Reflection Loss for Aluminum
- Magnetic Near-Field Reflection Loss for "Mu-Metal"

The sub-title and first paragraphs are as follows:

"Shielding electronic equipment against spurious signals is a necessity for system or subassembly compatibility and will require a metal of some type. In aerospace applications this becomes a critical problem, especially when weight is measured in terms of fuel.

"The graphs presented here have been constructed to assist the designer in determining the minimum thickness of metal required to achieve a desired level of shielding effectiveness. This is not the only consideration, however, since the total shielding effectiveness of any enclosure is dependent upon the mechanical construction (i.e., openings, covers, fastening techniques, etc.) as well as upon the type of metal and metal thickness.

"The equations upon which the curves are based are theoretical in nature and have been derived from transmission-line theory. Therefore, the curves delineate the theoretical attenuation versus frequency for the metals shown. The metals investigated were copper, 6061-T6 aluminum and 'Mu-Metal'."

AN ARTICLE MENTIONING COMPUTER GROUNDS

Lloyd E. Metcalf, Principal Engineer, Sperry Utah Co., Salt Lake City, Utah, has authored an article under the title "Be Practical About Using Op-Amps" in the August, 1966, issue of EDN. Paragraphs about grounds are as follows:

The Ordered Ground

"The manner in which the various grounds are connected to the central ground bus in the computer can have a profound effect on the behavior of the signal ground. By virtue of the fact that there are many amplifiers in the normal computer, many ground wires must be connected to the central ground bus. This condition dictates that the ground bus be physically long. There is consequently a wide range of choice in selecting the place where each ground wire is connected to the ground bus.

"Since it is desired to isolate signal grounds from current-carrying grounds, all signal grounds are connected to one end of the ground bus. Next, all dc grounds are connected in the order of increasing current flow. AC current and shield returns are now connected, again using the increasing current rule. Normally the ground bus is connected to the computer chassis, and the location of this connection on the ground bus is also important. At first glance, it might be thought that the signal-ground end of the bus should be connected to the chassis to provide the best possible ground reference. However, chassis ground is not a particularly dependable or predictable reference for analog computers, which are concerned with ground reference voltage changes in the order of a few microvolts. In the interest of providing maximum isolation to the signal grounds, the chass ground connection is made at or near the opposite end of the ground bus. The true ground reference point is then the noncurrent-carrying end of the ground bus. The chas ground end may be microvolts, or even millivolts, differe in potentail from the signal reference. This voltage lev will have little or no effect on the signal ground.

Ground Loops

"The fact that two or more grounds must be run from a central ground bus in the computer to each operational amplifier presents additional problems. If a time-varying electromagnetic field exists within the computer (the norm conditon in most electronic equipment), any loop of wire in the vicinity will be subject to induced voltages. The ground returns for signal and power potentially present such a loop, with the induced voltage appearing between the signal-and-power-ground points within the amplifier.

equation omitted

"This potentially troublesome problem may be avoided in two ways. The magnetic field may be eliminated or the loop area may be reduced to zero. One method that has been sucessfully used in reducing the loop area to a negligibly small size is to carry the two leads together in the same cable. To assure that the two leads are kept together, one is carried as the inner conductor and the other as the outer conductor of a shielded cable.

LIGHTNING DISCHARGES AND YOUR EQUIPMENT

Electronic Engineer, October 1966, carries a 4-page article with 5 figures, under the above title, by Elden B. Arrowsmith, Technical Staff Member, Electrical Systems Section, Electrical & Optical Dept., Aerospace Corp., El Segundo, Californai. The sub-head and paragraphs of interest are as follows:

"Damage from lightning discharges can be prevented or greatly reduced. If you want to know what precautions to take, learn how the damage is done and what methods can be used to prevent it.

"There is no evidence that any form of protection can prevent a lightning discharge. Damage comes from electromagnetic fields caused by the lightning stroke, voltage drops in the ground system, structural damage from burning or heat, and mechanical forces. The goal of protection, therefore, is to provide a path by which a discharge can be conducted to earth without entering a vulnerable part of the equipment.

Methods of Voltage Coupling

"There are three main phenomena that produce voltages in electrical circuits as a result of a lightning dischar They are:

"(a) Circuits magnetically coupled to conductors carrying lightning discharge current.

"(b) The result of IR drop from lightning-discharge current in the structure or ground-contact resistance.

"(c) The result of capacitive coupling to conductors carrying lightning discharge current.

"Lightning voltages coupled into circuits are usually the result of a combination of the three phenomena."

AUTOMATIC SWITCHING MAY SOLVE RF NOISE

Electronic Design, October 25, 1966, carries a news item with 1 chart as follows:

"Automatic frequency selection may be developed for high-frequency communications some day, if engineers determine that this approach can reduce atmospheric distrubances of radio waves.

"Sylvania's Electronic Systems Division has just set up two receiving/transmitting stations 400 miles apart to determine the effects of atmospheric changes on broadcasting. 'Accurate measurements of these disturbances will assist us in the design of automated long-distance communications equipment,' says Stuart Morrison, the division's director of engineering.

"It has been known for many years that sunspots interfere with high-frequency radio waves. An automatic transmitter such as that visualized by Morrison would detect the onset of interference in one portion of the frequency spectrum and shift a broadcast to a channel in an unaffected portion. Also, a certain amount of historical information could be programmed into the system. 'Frequencies employed for daytime transmission differ from those used at night,' says Morrison. 'The best frequencies for communications also vary from month to month and from year to year, depending on sun spots.'

" 'At present,' he continued, 'radio operators must monitor signals continuously to ensure that changing conditions in the ionosphere - several layers of electrically charged air between 50 and 500 miles above the earth - do not disrupt communications'. "

SCR AND UJT FORM NOISE-IMMUNE MONO

David M. Weignad, Design Engineer, Brookhaven National Laboratory, Upton, N.Y., has entered a schematic and the following text in the section "Ideas for Design" in the November 22, 1966 issue of Electronic Design. The text is as follows:

"Standard long-delay transistor monostables require bulky and expensive capacitors, as well as careful noise suppression techniques. In the circuit shown, the unijunction timer lowers this capacity while a low-impedance SCR circuit reduces false triggering from noisy input lines, power supply lines and ground loops.

"Circuits operation is as follows: Under quiescent conditions, SCR1 is ON and conducting I_{r1} current. V_{out} is about 1 volt. When a negative pulse occurs on the input lines, SCR1 turns off and V_{out} is 28 volts. This trigger pulse must be longer than the SCR turn-off time (about 40 us) and draw a current greater than I_{r1} - I_h (I_h = holding current of SCR1). Low power and/or short noise pulses will not cause false triggering. The unijunction timer circuit fires after a fixed delay of R3C3 seconds (100 ms in this instance), returning the circuit to the quiescent state. Time constant R2C2 is used to suppress noise near the end of this delay, when the unijunction is sensitive to noise. R2C2 can be deleted if desired.

"Applications of this monostable include high-current control type circuits around keypunches, SCR circuits, motor controllers, etc., where a relay or solenoid may be substituted for R1, as indicated in the circuit. The circuit can be designed to accommodate shorter or longer delays and higher or lower currents and voltages."

DESIGN AMPLIFIERS FOR LOW-NOISE

George D. Johnson, Section Head, Microwave Circuit Dept., Texas Instruments, Inc., Dallas, Texas, has written a 10-page article, under the complete heading "Design amplifiers for low-noise by carefully considering device selection, circuit configuration and parameters essential to optimum performance", in the November 8th, 1966 issue of Electronic Design. There are 13 schematics, figures and charts and bibliography of 22 references.

NOISE MEASUREMENTS ON ICs: DYNAMIC TESTS - YES; DC - NO

Electronic Design, January 4, 1967, contains a discussion by Dug Roy, Engineer, Industrial Products Group, Texas Instruments, Inc., Houston, under the above heading. It is in the "Ideas for Design" Section and contains two figures. The first three paragraphs are as follows:

"When integrated circuits are tested by dc methods, a meaningful evaluation of the IC noise behavior cannot be made. Such key measurements as noise feedthrough and noise immunity may be accurately determined only by dynamic testing.

"IC users should avoid dc tests even as a 'rough' index of the noise behavior, lest a perfectly good device be needlessly rejected as having too little noise immunity. Dc means may fail the IC whereas a dynamic measurement would indicate a passing noise immunity for the very same circuit.

"When a dc signal (step function) is applied to the gate of the IC (Fig. 1a), internal stray capacitances in the gate will become charged and the output will hold at some finite level. This output does not reflect the true noise feedthrough, because it resembles a step, rathe than the pulse waveform which is representative fo the noi quantity."

THE HALL EFFECT

Albert C. Beer has written a 7-page article in the December, 1966 issue of International Science and Technology under the above title. The sub-head and a summary are as follows:

" An unusual means of controlling electric fields is beginning to emerge from the laboratory. How widely it is used will depend largely upon the ingenuity of the materials man.

"In Brief: For 87 years now it has been known that a voltage is produced across a current-carrying conductor located at right angles to a magnetic field. This so-called Hall effect was always so small, however, that its application was limited to basic investigations into the electronic properties of solids. But in the middle 1950's compound semiconductors such as indium antimonide were perfected which, because of the high mobility of their charges, could generate Hall voltages and currents of quite respectable magnitudes. As a result, Hall-effect devices now appear useful for performing a variety of instrumentation and control functions, such as measuring power, transmitting signals, sensing position, and computing. Moreover, a number of other effects which - like the Hall effect - are based on the action of Lorentz forces are being used across a wide range of applications from accelerating rockets to cooling electronic circuits - M.F.W."

TECHNIQUES TO ANALYZE AND OPTIMIZE NOISE REJECTION RATIO OF LOW LEVEL DIFFERENTIAL DATA SYSTEMS

A 24-page booklet has been authored by Charles E. Engle, Staff Engineer, Dana Laboratories, Inc., Irvine, California 92664, under the above title. The Conclusion is as follows:

"The concepts and examples presented in this paper are directed to one purpose: to provide the system designer the means to analyze and, consequently, optimize the noise performance of a low level data system with respect to ground potentials.

"To this end, the equations utilized were not rigorous in the mathematical sense, but are sufficient to demonstrate basic principles and can be useful for design analysis. Recognize, too, that the bridge and thermocouple transducer circuits present were greatly simplified. Many of the circuit details encountered in actual transducer systems were omitted (balance potentiometers, switches, scaling networks, etc.). Only the components and circuit details having a direct bearing upon the noise problem were included.

"In conclusion, the following suggestions are offered as an aid to the system designer:

1. Always utilize driven guard shield techniques to maximize CMR ratio. Realize that this requires all elements of the input circuit to be contained within the guard shield.

2. Geometrically design the system to minimize area loops. Physically separate low level leads from high voltage sources whenever possible.

3. Establish a primary ground point for the system and bootstrap all other grounds from it. (This may involve the selective use of isolation transformers as some equipment manufacturers still refuse to separate circuit common from chassis or to install the bare minimum of shields in their power transformers; e.g., tape recorders, oscilloscopes.)

4. Determine the value of key system performance parameters; i.e., the maximum CMR that can be physically realized; the maximum common mode potential allowable with respect to system accuracy; the various ground return impedances of the system; the maximum allowable injection current from various active devices, such as bridge supplies, etc.

5. Whenever possible, particularly for data systems involving a large number of identical channels, construct an experimental circuit to test the validity of your design. This circuit can also be used to evaluate various manufacturer's products for performance. The information thus gained can provide the system designer with tremendous insight when determining procurement specifications."

ELECTROMAGNETIC SPECTRUM UTILIZATION - THE SILENT CRISIS

The Telecommunication Science Panel of the Commerce Technical Advisory Board has published an 85-page report on Telecommunication Science and the Federal Government for the U.S. Department of Commerce under the above title. The first two paragraphs of the Foreword are as follows:

"Most people know that radio, television, long distance telephone, radar, police radio, etc., play important roles in their daily lives. Many of the more thoughtful are aware that telecommunication services are important, indeed essential, participants in all facets of the growth of our nation and even of our civilization. Relatively few, the technically inclined, know that telecommunications depend on a national resource--the electromagnetic frequency spectrum; a technical concept which put the word 'wireless' into our vocabulary.

"The electromagnetic spectrum has become a silent partner vital to all our national enterprises. If it were suddenly to disappear we would have calamitous confusion and would have to retrogress many aspects of our society by as much as half a century before we could begin to function as a nation again. It is doubtful if anyone fully comprehends either the full impact on modern society or the interactions of all the technical, economic. social, and political complexities of our silent partner. The selected groups who have attempted, during the past forty years, to achieve some level of understanding, have repeatedly warned us that our silent partner is ailing. In recent years the warnings have become more urgent and the symptoms have become more numerous and even obvious to those sectors of our industrial life which need to extend the use of this silent partner for the benefit of their business."

Copies may be obtained by writing to the Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402 - price 50 cents.

A COMPARATIVE ANALYSIS OF BIOLOGICAL EFFECTS OF MICROWAVE ENERGY

Dr. Joseph H. Vogelman, Director of Electronics, Chromalloy Corporation, 169 Western Highway, West Nyack, N.Y. has prepared a 7-page paper under the above title. The Abstract and first paragraph of the Introduction are as follows:

Abstract

"This paper analyzes and compares the results of experimentation and statistical data collection both in the Unites States and abroad in tne field of biological effects of microwave energy. The spectral region of interest extends from a fraction of a centimeter to approximately 50 centimeters, i.e., those wavelenghts where biological specimens and man are commensurate in physical dimensions with the wavelength used. The comparative analysis groups the experimental and statistical results into three categories: thermal effects (average power), peak thermal effects (peak power), and non-thermal effects (resonance, etc). Some conclusions are presented based on analysis of the limited data available. New investigations and methods are suggested to help supply reliable data which could lead to useful medical tools.

Introduction

"Since the introduction of high power radar and communcation equipment into general military and civilian use, great fear of the potential damage to the biological functions of man from this type of radio energy has produced fairly large number of experimental and statistical investigations into the effects of microwave energy. Unfortunately, the majority of the investigations suffered from inadequacies of either technical facilities and microwave measurement skills or insufficient control of the biological specimens and the criteria for biological change. However, over the last ten years a series of research programs have begun to produce results in certain areas which can be considered sufficiently reliable to permit drawing some generalized principles. More importantly, however, we are now in the position to define the areas that require furher research and to establish techniques for producing results that could be considered reliably conclusive."

Copies may be obtained by writing to Dr. Vogelman.

AF DEVELOPS CONDUCTIVE GREASE

Technology Week, November 21, 1966, on page 4, carried the following item under the above heading:

"An electrically conductive grease for use in the silo closure bearing system at Minuteman ICBM sites has been developed by the Air Force Materials Laboratory, Wright-Patterson AFB, Ohio. The project was a cooperative venture among the Aeronautical Materials Laboratory, the Naval Air Engineering Center and the Materials Laboratory. Besides being an effective lubricant, the grease also grounds the bearings, says project engineer J.J. Sullivan, AFML. The grease is 45% graphite and retains its properites over long-time periods and performs adequately in hot and cold environments. A similar grease, but without the conductive constituents, is used for lubricating bearings in several operational aircraft."

LASERS, FIBER BUNDLES YIELD RFI-IMMUNE EXPLOSIVE INITIATOR

Technology Week, November 14, 1966 carries an article with three illustrations by Rex Pay under the above title. Paragraphs of interest are as follows:

"El Segundo, Calif. - Compact laser units and efficient glassfiber light pipes now make feasible explosive initiators that are claimed to be immune from radio frequency interference (RFI).

"Severe problems in missiles, boosters and spacecraft have been caused by premature ignition or dubbling of hot wire or exploding bridgewire initiators caused by RFI. In the Apollo spacecraft system, which has about 145 initiators, some 240 lb. of extra weight is needed in RF shielding for protection against this hazard.

"The problem stems from the fact that the two conducting leads that enter the hot-wire or EBW initiator can act as antennas. Any RFI they pick up will heat the explosive within the initiator. Also, RFI can cause initiation by direct corona and arcing within the explosive mix. The geometry of initators and the characteristics of explosives currently used combine to make most initiators particularly sensitive to the X-band frequencies commonly used by high-powered pulse radars.

"Preventing RFI - The laser - energized explosive device (LEED) developed by Space Ordnance Systems, Inc., avoids the RFI problem by having no leads into the initiator and using insensitive secondary explosives. The explosive is initiated by shining intense laser light into the explosive material through a small window in the container, instead of by bringing in electrical energy by conducting leads."

Proceedings of the IEEE

ITEMS OF INTEREST IN PROCEEDINGS OF THE IEEE

The following items of interest appeared in the November, 1966 issue of the Proceedings of the IEEE:

Noise in FM Receivers with Negative Frequency Feedback

"FM receiving systems employing negative frequency feedback have characteristics which make them particularly attractive for a number of applications. The feedback enhances the quality of reception by increasing the receiver sensitivity, but there have been varying opinions as to how much increased sensitivity could be obtained. The work reported in this two-part paper was undertaken to clarify the physical effects responsible for the threshold behavior of FM receiving systems, especially those with frequency feedback. In Part I, the author introduces a new approach for the determination of threshold effects, an appraoch having the advantages of lucidity and mathematical simplicity. Suitable approximations allow the output spectra and signal-to-noise ratios to be derived with relative ease from the amplitude distribution of the noise envelope. The method is first applied to conventional FM systems and then extended to the more complex situation where negative frequency feedback is used. The relations derived show that the improvement in noise conditions is achieved through the reduction of the IF bandwidth made possible by the feedback. Part II presents measurements corroborating the theoretical analysis. Rules for optimal design are given which permit the lowest threshold value to be realized without impairment of the overall system performance."

Combination RF Radiation and Fluid Pressure Seal

A letter by M. B. Hall, N. T. Larsen and W. E. Little, National Bureau of Standards, Boulder, Colorado, appeared on page 1585. Paragraphs of interest are as follows:

"Radiation leakage by extraneous paths from sources to detectors frequently limits the dynamic range of precision electrical measurements in the radio-frequency range. Elimination of leakage paths becomes more difficult with increasing frequency. Correct use of gaskets made of pressed woven metal eliminates measurable leakage but does not insure a low, stable reflection from waveguide joints. Furthermore, commercially available woven-metal gaskets require special grooved flanges.
Lead washers supress leakage sufficiently for many purposes when freshly inserted between waveguide flanges, but their effectiveness decreases with time, particularly if they are removed and reinserted. A commercial (recent) gasket material consisting of silver powder embedded in vinyl polymer has proved to be very effective, at least when fresh. A recent publication (1) describes RF leakage tests on a number of gaskets of different designs and materials.

"A new type of microwave gasket for use, for example, between waveguide flanges has been developed at Boulder Laboratories. It is convenient, requiring only moderate pressure, and may be reused. The new gasket can be made thin, and hence, light. It provides simultaneously a microwave radiation and a fluid pressure seal, and the reflection it introduces can be made small. It is expected that variations of the materials of construction will provide for various other combinations of desirable properties."

Unwanted Rosponses in VHF Quartz Crystal Units

A letter written by E. A. Gerber, Electronic Components Lab., U.S. Army Electronics Command, Fort Monmouth, N.J., starts on page 1613. Paragraphs of interest are as follows:

"It is well known that the main problem in the field of VHF crystals is the suppression of unwanted responses, specifically, of the so-called inharmonic overtone. They are caused by phase reversals of thickness modes in the plane of the crystal plate. It has been shown (1) - (4) that by decreasing the diameter of the electroded area these unwanted responses can be suppressed. Further progress towards single-resonance crystals was made when it was found that the thickness of the electrodes also had an influence on the unwanted response spectrum (5)-(7). The development of the energy trapping concept (8) provided an explanation of the phenomena involved in the supression of unwanted responses.

"If the crystal plates become very thin, another type of unwanted mode becomes apparent (2), (3). This type is cuased by the lack of parallelism of the two major crystal faces."

IEEE Transactions on Power Apparatus and Systems

COMMUNICATION CIRCUITS ON 500-KV LINES

T.M Swingle and H.I. Dobson, Tennessee Valley Authority, Chattanooga, Tenn., have co-authored a 6-page paper in the October, 1966 issue of the IEEE Transactions on Power Apparatus and and Systems. A section of interest is as follows:

Radio Interference Measurements

"Radio interference investigations on TVA's portion of the Johnsville-West Memphis 500 kV line are also far from complete; however, a limited number of RI measurements at 1 Mc were made at 20 different locations along the line, using a Stoddart NM20B noise meter with a 1/600-ms time constant. Weather conditons varied widely during the tests. Typical measurements made during four types of weather as observed at various locations along the line during May and June of 1965, are shown in Fig. 14. All readings shown are in microvolts per meter and were taken 100 feet lateral distance from the outside phase conductors. The one measurement shown in the rain column was made during the first few minutes of a light rainfall.

"While these measurements are few in number, were taken under various weather conditions, and are by no means adequate from which to draw final conclusions, nevertheless they do represent actual conditions as found in the vicinity of a 160-mile line operating at 500kV. Two fixed monitoring stations are now in service along the line with provisions for recording the RI level at 100 feet lateral distance from the outside phase conductors as well as ambient RI in the general vicinity. These monitoring stations will remain in service for an extended period, thereby providing much more detailed information.

"As of this date not a single radio or television interference complaint has been recieved."

IEEE Transactions on Aerospace and Electronic Systems

JANUARY 1967

Effects of CW Interference on Narrow-Band Second-Order Phase-Lock Loops - by C. L. Britt and D. F. Palmer

"An experimental study is described of the effect of continuous wave interference and white noise on a second-order phase-lock loop. The reciprocal of the loop mean-square phase error is used as an index of performance; and the effect of interference levels that do not cause cycle skipping or loss of lock is described in terms of this index. Loop thresholds are determined by measurement of cycle skipping rates. Stationary or slowly sweeping CW interference caused a degradation in loop threshold of roughly 3 dB for every 6 dB of interference power above the noise power level. The effective loop signal-to-noise ratio was decreased approximately 1 dB at interference to noise power ratios of -3 dB. Interference levels equal to the signal level consistently caused loss of lock, regardless of the loop signal-to-noise ratio."

IEEE Transactions on Electron Devices

DECEMBER 1966

Signal and Noise Response of High-Speed Germanium Avalanche Photodiodes - by H. Melchior and W. T. Lynch

"Germanium avalanche photodiodes, providing gain at microwave frequencies, have been fabricated and tested. The diodes, which are described, employ a guard ring structure to achieve a uniform, microplasma-free, multiplying region with an active diameter of 40 um. Low-frequency chopped-light current gains of greater than 10, have been obtained at room temperature for a carrier wavelength of 1.15 um. In the normal operating range, the signal output power is found to vary as the square of the multiplication, and the noise is found to vary as the cube of the multiplication. This limits the maximum useful multiplication of the diode to the level that gives a diode noise equal to the receiver noise. A small-signal equivalent circuit with lumped elements corresponding to the physical process occurring within the diode is introduced to describe the small-signal behavior. The model is valid over the entire multiplication range up to frequencies of about 10 GHz."

CONTROL OF MAGNETIC PROPERTIES

OF SCIENTIFIC SPACECRAFT

John W. Lindner   Carol A. Eberhard
TRW Systems Group

John W. Lindner and Mrs. Carol A. Eberhard, TRW Systems Group, One Space Park, Redondo Beach, California, have authored a 12-page paper with the above title. The Abstract and a paragraph of interest are as follows:

"Accurate measurements of magnetic fields from satellites and space probes require that the magnetic field of the spacecraft be reduced to an absolute minimum. This requires close control in the design and test of all components of the spacecraft. Procedures are discussed which have been followed on the Orbiting Geophysical Observatories (OGO) and Pioneer programs in order to reduce magnetic fields.

"In theory it is possible to build a completely non-magnetic spacecraft by using only completely non-magnetic components. In practice this is impossible. Many components depend upon permanent magnets for proper operation. Examples include magnetic latching relays, tape recorder erase heads, some coaxial switches, and traveling wave tubes. Other components, such as transformers, valves and inductors, require high-permeability material for proper operation. Many radio frequency devices make extensive use of ferrites and ferromagnetic material."

New Products

Solar Electronics Company

Solar Electronics Company, 901 North Highland Avenue, Hollywood California 90038, has brought out a sales catalog covering their instruments, components and accessories for the RFI/EMC engineer. Instruments covered are the RFI Transient Generator, Power Sweep Generator, 100-Watt Solid State Audio Amplifier, Audio Isolation Transformer and Line Impedance Bridge. An RFI Prediction Graph for Rectangular and Trapezoidal Pulse Interference is included as well as a 3-page Reactance Nomograph covering the areas from 1 C/S to 1 KMC/S.

Static Grounding Device for Shoes

The General Electric Equipment Co., Limekiln Pike & Williams Ave., Philadelphia, Pa., 19150, has developed Conductostrap, a safety device worn over ordinary shoes to control body static. The device is made of conductive butyl stripping with high abrasion resistance. The strap eliminates accumulation of static on the body of the wearer.

Explosion Proof Rotary Switches

Janco Corporation, Burbank, California, has brought out a line of totally enclosed explosion proof rotary selector switches. They go from micro-miniature to standard sizes.

Precision RF Coxial Connectors

General RF Fittings, Inc., 702 Beacon St., Mass. 02215, has brought out a line of precision RF coaxial connectors, including miniature connectors, to meet Specifications MIL-Q-9858A, MIL-I-45028A, and NASA Specification NPC 200-3.

NEW CONNECTOR AND COMPONENT FILTERS

Denesco, Inc., 2408 San Mateo Pl.,N.E., Albuquerque, New Mexico 87110, has brought out a new line of connector and component filters as described in a 10-page article titled "Tiny Filters Block the Path of Radio-Frequency Interference" in the October 31, 1966 issue of Electronics. The new filters permit miniaturization because of the development of a new ceramic dielectric material, new methods to produce extremely thin and small ceramic tubes of considerable mechanical and electrical strength, and development of extremely lossy magnetic core systems with a new monolithic structure filter. Copies of the article and samples of the filter may be obtained by writing to the company.

New Shielded Vent Panels

Technical Wire Products, Inc., 129 Dermody St., Cranford, N.J. 07016, has brought out a new line of 40 standard Teckcell Ventilating Panels designed to fit standard 19" and 24" EIA cabinets with open or closed mounting holes. 100 dB of total shielding effectiveness is claimed while allowing over 95% air flow through the panel.

Copper Base Conductive Inks

Fritz Chemical Company, P.O. Box 17087, Dallas, Texas 75217, has developed a pure copper-filled electrically conductive thixotropic Epoxy ink suitable for casting or painting. It exhibits excellent conductivity and forms substrates. Fritz-Copper 150 is self priming and has the strength of over 5000 pounds per square inch.

New Manufacturer of Absorption Filters

J.R. Manufacturing Company, Inc., 47 Werman Court, Plainview, N.Y. 11803, has developed a new line of absorption filter which claims to eliminate all of the detrimental features of the lumped constant filter by providing a true distributed type filter whose attenuation characteristics are produced by the energy absorptive ferrites and ferromagnetic materials when exposed to electromagnetic energy. The end result is claimed to be a nearly perfect stop band attenuation characteristic, no ringing effects and high overload capabilities. Single phase and three phase units from 1 amp to 200 amps are available.