IEEE NEWSLETTER

ELECTROMAGNETIC COMPATIBILITY GROUP

Number 37 March 1965

SEVENTH NATIONAL EMC SYMPOSIUM

Plans for the Seventh National Symposium in Electromagnetic Compatibility to be held in New York City June 28-30, 1965 are progressing rapidly. O. P. Schreiber, Chairman, Exhibits Committee, c/o Technical Wire Products, Inc., 129 Dermody St., Cranford, N. J. 07106, is in charge of the list of exhibitors and applications and contracts for exhibit space. A company may be a sponsor for $100. while booth rental costs vary from $126. to $390. for the 3-day Conference. Further details may be obtained by writing to Mr. Schreiber. The Symposium Cocktail Party is planned to be held in the exhibit area. The following are the subjects which will be covered by the papers:

1. Measurement Techniques
2. Suppression materials, components, and their application
3. Electro-Magnetic Pulse (EMP) Problems
4. Advanced EMC Theory
5. Radiation Hazards
6. Interference Prediction
7. Susceptibility - from DC to light
8. Specification Considerations

500 word abstracts should be submitted for review to:

D. Fidelman, Chairman Technical Program Committee
Electro-Magnetic Measurement Company
50 Baiting Place Road
Farmingdale, N. Y.

RFI-EMC PANEL SCHEDULED FOR IEEE SHOW

The RFI-EMC Panel which your editor originally said was scheduled for the Seventh National EMC Symposium in June will be held, instead, on Monday afternoon, 22 March 1965, at the New York IEEE Show with the following title and personnel:

Radio Spectrum Utilization as a National Problem

Chairman: Mr. A. H. Sullivan, Jr.
(HRB-Singer, Inc.)
Editor, Transactions on
Electromagnetic Compatibility

Panel Members:

Mr. Ralph Clark
Special Assistant to the Director
of Telecommunications Management, Exec. Office of the Pres.

Mr. Richard P. Gifford
(Gen. Mgr., General Electric Co.
Lynchburg, Va.)
Chairman, JTAC Subcommittee
on Electromagnetic Compatibility

Mr. Curtis B. Plummer
Exec. Dir., Federal Communications Commission

Mr. William B. Plummer
Former Chaiman, Interagency
Radio Advisory Committee
Chief, Frequency Management Div.
Office of Director of Telecommunications Management
Executive Office of the President

Mr. Henry Randall
Special Assistant to Asst. Dir.
Communications & Electronics
ODDR&E, DOD

CHAPTER ACTIVITIES

Boston

The Military Electronics Electromagnetic Compatibility Group met on December 10, 1964 at which time Mr. Arnold R. Bailey, Mitre Corp., Bedford, Mass., gave a paper on "Considerations Pertaining to Nuclear and Lightning Transient EMP Effects on Communications Systems and Equipment."

Mohawk Valley

A meeting was held by G-EMC on November 10, 1964 and Mr. John Waitkeneus, American Electronic Labs., Colimar, Pa., gave a paper on "Control Techniques for UHF-VHF Receivers."

New Orleans

There were two meetings held by this Chapter; one on July 22, 1964 at which time Mr. Tom Herring, Boeing Co., Huntsville, Ala., spoke on "A Decade of db - Changing Face of Radio Noise"; and another meeting was held on October 21, 1964 wherein, Mr. O. P. Schreiber, Technical Wire Products, Inc., Cranford, N. J., gave a paper on "Radio Frequency Interference Control Using RFI Gaskets."

Philadelphia

On Oct. 20, 1964, Mr. Zigmund V. Grobowski, Grobowski & Associates, Washington, D. C., spoke at a meeting of the Electromagnetic Compatibility Group. The topic of Mr. Grobowski's paper was "Applications of Shielded Enclosures."

San Francisco

Two meetings were held by G-EMC; one on June 10, 1964 in which a paper was presented - "Instrumentation on Wide-Band Spectrum Analysis" - by Mr. H. L. Halverson, Microwave R&D Labs., and Mr. A. Fong, Hewlett-Packard Co., Palo Alto, Calif.; another meeting was held on October 21, 1964 at which time Mr. William Nye spoke on "EMC Aspects of Mobile Communications."

Seattle

On Sept. 23, 1964, the Electromagnetic Compatibility Group met and Mr. W. M. McCullough, The Boeing Co., Aerospace Div., Seattle, Wash., spoke on "Semiconductor Switching Circuits with Minimum Susceptibility."

Washington, D. C.

The G-EMC held two meetings; one on Sept. 10, 1964 at which time Mr. Wm. J. Mattox, Electro-International, Annapolis, Md., spoke on "Conducted Interference from Transformer Transients"; another meeting was held on Nov. 12, 1964 and a paper titled "RFI Prediction Data - Shotgun or Rifle?" was presented by Mr. Kenneth G. Heisler, Jr., Jansky & Bailey, Div., ARC, Alexandria, Va.

MAXIMILIAN WARE DIES OF HEART ATTACK

Maximilian Ware, recently chairman of the Washington Chapter of the IEEE G-EMC died in Arlington, Va., October 27, 1964 of a heart attack at the age of 63. Mr. Ware was a pioneer in Government radio frequency compatibility efforts in the Office of the Chief Signal Officer and initiated the first Government contracts for RFI studies and measurements by the Armour Research Foundation, and the Georgia Institute of Technology. Mr. Ware was currently serving on Study Groups I, II, and XIV of the International Radio Consultative Committee (CCIR) and was recently a member of the U. S. delegation to the Plenary Assembly of the International Special Committee on Radio Interference (CISPR) in Stockholm, Sweden, August 1964. He was currently employed as a scientist-engineer in the Electronics Branch, Development Division of the Army Material Command, where he as responsible for all radio frequency compatibility activities, including the application of the Electromagnetic Environmental Test Facility at Fort Huachuca, Ariz., to the functions of radio frequency compatibility measurements. He also served as Army Representative on various Technical Advisory Groups on electromagnetic compatibility matters.

UNIVERSITY OF PENNA. TO GIVE SYSTEMS EMC SUMMER COURSE

A two-week seminar on the above topic will be offered at The Moore School of Electrical Engineering, University of Penna., beginning on June 14, 1965. Its purpose is to quantify this critical technical problem for the benefit of those persons who have responsibilitities in the following areas:

management
system engineering
design engineering
operations

The basic approach to be used is that the ultimate solution of electromagnetic compatibility problems depends up (1) the adoption of an adequate systems point of view, (2) a recognition of the differences between intra-system and inter-system compatibility problems, and (3) an understanding of the fundamental scientific principles involved. Attention will be directed to economic considerations, including the consequences of inadequately accounting for electromagnetic compatibility requirements at the inception of systems engineering, as compared to the use of quick-fix and retro-fitting methods. In addition to a fairly extensive review of the scientific principles and their applications in compatibility problems, extensive treatment will be given to statistical methods in interference analysis and the role of large-scale digital computers. The subject breakdown of the lectures is planned to include the following:

Compatibility and the electromagnetic spectrum
Systems considerations, models
Classification of System problems
Applications of mathematical probability & statistics
Technical considerations
Characterization of emitters
Characterization of susceptible devices
Coupling phenomena, antennas & transmission lines
Shielding and grounding
Propagation
Susceptibility criteria & methods of system evaluation
Measurements--their significance & special problems
Interference control techniques in detail, with examples, - specifications, filters, blankers, side-lobe cancellation, correlation, signal shaping frequency assignment.

The program is self-contained and no special background on the part of the student beyond the Bachelor's Degree will be assumed. Lecturers will include members of the faculty of the Moore School who have had up to 20 years of experience in the field, as well as a number of well-known authorities from the various departments and institutions who are working on current systems problems. The schedule will include approximately 60 hours of lecture and be arranged to permit at least 25% of the time to be devoted to discussions by the participants of current problems.

The enrollment fee is $250. (a special institutional rate of $125. is available to educators). A complete set of notes covering the lectures will be distributed. Lodging is available in University dormitories, or in nearby motels and hotels. Applications or further details may be obtained by writing to Special Summer Sessions Office, The Moore School of Electrical Engineering, University of Penna., Philadelphia, Pa. 19104.

M. I. T. TO GIVE EMC SUMMER COURSE

The Massachusetts Institute of Technology, Cambridge, Mass., is giving a summer course on Electromagnetic Compatibility starting Monday, August 16, through Friday, August 27, 1965 described as follows:

"The general level of man-made electromagnetic noise is rising; there is also a broadened interest in low-level, wide-band measurements and a consequent increase in equipment sensitivity and susceptibility to interference. The resulting problems range from simple electric-shaver interference with a nearby radio or television receiver to the extremely complex noise associated with large-scale, diverse organizations such as university research complexes and electronic industrial parks. The cost of such interference is high, in terms of time lost, reduced efficiency of communications and research and sometimes, lives. Aside from the obvious problems involving commercial and military aircraft, new techniques in medicine - such as the cardiac pacemaker - involve interconnection of electronics equipment and highly sensitive human nerve tissue; in this case, electromagnetic interference, however transient, might mean death for th individual involved.

"This two-week Program will detail the nature of interferenc problems; where possible, solutions will be outlined. Case studies will be presented which illustrate measurement techniques, proposed action, and results. It is hoped that some reasonable estimates of the cost versus effectiveness of various interference suppression program can be presented.

"It is expected that the course will be of interest to technical people in many fields; for example, electrical engineers, medical and biological researchers involved in neurological investigations, architects and others involved in the design and utilization of structures for research and development laboratories.

"The Program will be under the direction of Prof. Robert P. Rafuse; lectures will be given by members of the Dept. of Electrical Engineering and invited guests. Tuition - $350."

FREQUENCY WRITE-UP OF TENTH TRI-SERVICE CONFERENC

FREQUENCY, 167 Corey Rd., Brookline, Mass. 02146, has kindly given its permission to reprint the editorial part of its write-up appearing in their January/February 1965 issue, of the Tenth Tri-Service Conference on Electromagnetic Compatibility held in Chicago, Nov. 17-19, 1964. What has not been reprinted are several pages of interesting comments and a complete list of Conference papers.

The purpose of the Conference was described as "To see what headway had been made in the state-of-the-art" which was followed by the following descriptive paragraph:

> "What did the 500 or so scientists and engineers who attended this meeting hope to accomplish? Did any significant patterns emerge from the technical interchange? What does the future hold in store for EMC? Read this Conference Report and you'll get the answers to these and other questions in a review of meeting highlights."

The write-up then continues as follows:

CONFERENCE PERSPECTIVE - Those who listened to the papers and took part in the informal corridor and hotel-room discussions at the Tenth Tri-Service Conference on Electromagnetic Compatibility in Chicago this past November realized, more than ever before, that they were witnessing the buildup of a scientific explosion. In testimony to the growing problems in the EMC/RFI area was this comment by Rear Admiral Joseph E. Rice in his keynote address: "EMC has sneaked up on the military and now it is sneaking up on the nation."

One of the problems that is "sneaking up on the military" is the transfer of problems in military logistics from men's minds to magnetic tapes and the creation of better and faster methods of gathering and collecting technical information. As R. D. Larson of Bell Aero-systems Company said, in his description of the Army Environmental Data Collection and Processing facility at Ft. Huachuca, Arizona, "Electronics systems are becoming so complicated that an army cannot move randomly." It's our feeling, from this and other opening statements at the Conference, that if, by chance, the Navy and Air Force should also happen to get into the same war, technical chaos might result, especially if battles were fought during thunder or magnetic storms. Troops might even have to revert to bows and arrows!

J. J. Krstansky's of the IIT Research Institute, and Conference Chairman, sounded the broad purpose of the meeting by pointing out to those present that "there is an educational responsibility to pass on the Conference's technical discussion to associates." Since military representatives were a minority in the 500 or so attendees, this call was especially directed toward civilian activities and implied a warning that civilian problems lay ahead which would require many of the same solutions as now face the military. Krstansky's remarks also inferred that civilian activities owe the military a debt to discuss their problems in public.

After reading between the lines of the Conference presentations and sifting through the remarks of the registrants, present electromagnetic compatibility problems seemed to boil down into five general requirements:

Faster testing,
Combined specifications,
Compatible environments,
Improved prediction methods
Protection from transients.

In addition, there was strong sentiment for immediate attention to such topics as component reliability under unknown conditions, terminology, internal communication of ideas, personnel training, over-complexity of equipment, and increasing expense.

FASTER TESTING - One of the most important terms introduced into technical language during the past decade is spectrum signature. It describes the entire electromagnetic environment created by an electric or electronic system, device or component. Individuality of written signatures imply that, no matter how many devices or components are made, each will be slightly different from the others, and probably a function of their operational environment. As a matter of fact, it's become the custom to make spectrum signature tests of three or more samples and take an average of the results for specification purposes.

When in many cases, it takes from three days to a month to make a spectrum-signature test, and it costs between $500 and $50,000, it's quite apparent that less-costly methods have to be devised and adopted. In hopes of developing new instrumentation and faster testing methods, a number of companies are now working on automatic electromagnetic spectrum scanning and plotting equipment which can, for example, reduce a run of RF measurements from 16 man-hours to 3 minutes. Another approach would be to incorporate additional EMC test equipment into completely automatic test consoles such as that described by Henry Hoffart of General Electric and N. Ball of NASA in Session 2. Tests could then be programmed and results evaluated by a computer complex. Details of this automatic test system were contained in a paper entitled "EMC Control Effort for the Ace-S/C System (Apollo Program)" which appears in this issue of FREQUENCY as part of the Conference report.

Spectrum signatures are only one of many requirements in determining electromagnetic compatibility. Others call for continual monitoring of environments in search of possible interference signals and to carry out enemy surveillance, performance degradation studies, and new testing applications in such areas as production. "The FSM-17 - A New Approach to Radar Spectrum Signature Recording," a paper by A. E. F. Grempler of the Bendix Corp., Baltimore, Md., explaining a measurement tool capable of recording the three-dimensional pattern of a radar set at its actual operating site, was an especially informative treatise on measurement techniques. Another paper, along the same lines was that by J. F. Spina of the Rome Air Development Center entitled "A Method for Transmitting Radar Azimuth Data for Antenna Pattern Recordings." Other pertinent remarks on new test equipment and test methods were given in "Broadband Susceptibility Testing" by E. S. Warchaizer of the General Electric Col, Philadelphia, Pa., and "Navy Field Strength Meter Measurements in a Quasi-Absolute Monopole Field" by D. Clark, H. Lasitter, and R. Hitchcock of the U. S. Naval Civil Engineering Laboratory, Port Hueneme, Calif.

COMBINED SPECIFICATIONS - As use of the electromagnetic spectrum becomes more and more complex and expensive there is a growing demand for a single governmental policy affecting all aspects of electromagnetic compatibility. F. J. Nichols, President of Genistron, Inc., expressed this in the opening paper at Chicago when he remarked: "In the EMC area alone,, as it's generally known today, we have major specifications issued by each of the Tri-Services and NASA in addition to FCC rules and regulations. I fully agree that the Tri-Services' needs are each different; yet I feel, as numerous others have stated, that we need common meters, common test procedures, shielded rooms, etc. When we say microvolts per meter, dbm of power, ohms, or use other standard definitions, we do not qualify these as Army, Navy, Air Force or NASA definitions."

Admiral Rice had also commented on this need in these words: "We have to get better instrumentation and better standards. The problem is for all of us. It is a national problem and we will have to substitute sophistication for brute-force methods. EMC is the enemy of the electronic age. If we cannot control the enemy, we cannot control the electronic age."

In connection with the need for combined specifications, Messrs. Powers and Moore of the Rome Air Development Center presented an expecially useful and appropriate review of the new MIL-Std-826 entitled, "A New Guide to the Control of Electromagnetic Interference in Military Equipment." This excerpt of their introduction typifies the increasing effort to lay down some ground-rules for work in the EMC area: "This new standard is meant to replace the interference specifications now in use by the Air Force. Hopefully, it will accepted by the Army and Navy, and will eventually become a common interference standard for the Dep. of Defense. Tests and limits outlined compromise the requirements of the three Services to produce a document that is acceptable to all. At the present time, contractors are required to instrument their laboratories to perform tests required by several specifications. A common interference document can eliminate the excessive equipment required to comply to the various requirements. Also its common use will eliminate conflicts where equipment must meet the requirements of two specifications, one of which is more stringent than the other."

COMPATIBLE ENVIRONMENTS - More and more authors of EMC papers now stress the importance of initially determining the environment in which a system or component will operate before specifying design criteria. Ideally, you want a compatible environment - one in which potentially interfering signal levels are kept below the susceptibility levels of the operating systems. At our missile launching bases, standard procedural instructions are now authorized for the control of all electromagnetic energy, and EMI reduction programs are in operation for all offending emissions.

As the state-of-the-art progresses, shielding materials should be incorporated into original construction to provide attenuation of signals from instrumentation. All of this advance thinking is especially advantageous in cases where it may not be economically feasible to control, suppress, or take care of any incidental malfunctioning, or degradation of instrumentation and equipments in the immediate vicinity.

M. D. Aasen of the Electromagnetic Compatibility Analysis Center in Annapolis, Md. considered this problem in his paper "Performance Degradation Concepts in Ground Terminal Satellite Tracking and Communications Systems. "In a satellite communications system, " Aasen noted, "the ground terminal station must be compatible with the electromagnetic environment in which it is to operate." J. V. LeFort and R. S. Pugh of the Naval Air Test Center, Patuxent River, Md., in their paper "Facilities and Techniques for the Analysis of Electromagnetic Compatibility and Susceptibility of Naval Aircraft Weapons Systems," stated that electromagnetic compatibility testing must be performed in an area with the lowest possible ambient interference conditions ... where the background noise level is not greater than 4 db in the inherent background noise level of any receiver tested.

Jorgensen, Goldman, and Schulz of the Boeing Company, Renton, Washington went into this matter still further. In "The Electromagnetic Environment of Transport Airplanes" they maintained that "a prime requisite to the performance of system electrointerference analysis concurrent with system and installation design is an accurate appraisal of the total electromagnetic environment in which the system is to function and the reciprocal effects between environment and system components."

If local electromagnetic conditions were the only consideration in establishing compatible environments for the testing and operation of electronic equipments, it would be a comparatively simple matter to evaluate and control such environments. But environments which have to be electromagnetically compatible are rapidly becoming a worldwide problem for three reasons: equipment comes from different countries, commercial systems must operate in changing locales (round-the-world airlines and transcontinental trucking, for example), and constantly-changing military assignments. Factors which affect compatible environments such as topography, ground conditions, power availability, methods of transmission, frequency allocations, and others, all have to be considered for favorable results. Since the military is exploring all phases of this question, it described some of them in various Conference papers.

For instance, in Grempler's paper on the FSM-17, the following statement appeared: "The mobility ... is particularly important when it is recognized that there are thousands of radar sites located all over the world and that any one of them is a potential source of interference to other communication equipment. The successful use of the ASM-13 led to the conclusion that an airborne antenna-pattern analyzer capable of operating over a large frequency range would be the best answer to the problem of obtaining spectrum signatures of pulsed radar."

In the same vein, Larson's previously-mentioned paper described the activities of the Army at Fort Huachuca. Mr. Larson explained that the mission of the Office of the Chief of Communications - Electronics is to achieve coherence in the total Army communications - electronic program, from the conceptual stage through research and development, evaluation, production, issue to troops and operational use ... According to the author, general responsibilities include the provision of:

> Technical support to the Frequency Management Division (FMD) in the areas of frequency assignment, frequency allocation, and long-range frequency management planning for the Army.

Support to the DOD ECP through assistance in collection and provision of data for the Electromagnetic Compatability Analysis Center (ECAC) joint efforts, and through technical assistance to the FMD in its monitoring and advisory responsibilities with respect to the ECAC and the DOD program,

Support to the Army ECP through the provision of tactical map deployments and other environmental data,

Support to the FMD in defining and refining the Army problems which are to be investigated by the ECAC or the Electromagnetic Environmental Test Facility (EMETF), and

Support to the FMD in deriving appropriate operational action based on the results of the ECAC and EMETF compatibility evaluations.

Lars on went on to state that the major EDCPF support to the Army compatibility program is in the statement of problems and in the preparation of environmental descriptions of problem areas. The problems and environmental descriptions are developed as simulated tactical deployments (may deployments) of combat forces operating anywhere in the world in current or future time periods. "They thus provide the environmental tools for compatibility analyses of tactical situations prior to any actual employment," the author explained.

W. G. Duff and K. G. Heisler of Jansky and Bailey also got down to cases in their paper "The Effects of Sites Upon the Radiation Characteristics of Antennas." Most significant was their observation that "numerous comparisons of the type shown ... add to the mounting evidence that the effects of the site must be considered in interference prediction and analysis."

From this and the other papers in the session on antennas, it became evident that electromagnetically-compatible environments are not easy to come by, and many felt that the Conference papers only touched on this problem since entire meetings could be - and perhaps should be - devoted to this subject.

PREDICTION - Prediction is a relatively new term in general EMC language although it has been used by the military for many years. It covers performance degradation in electronic devices in present and future environments and is generally expressed by the ratio of signal to interference power. When applied to research and development concepts, it attempts to forecast the interference levels and characteristics which determine the environments in which a new system will have to operate, and thus establishes the design parameters. When applied to actual operational use, it means finding "worst case" conditions from different types and intensities of electromagnetic interference present.

Capt. C. L. Hudson and Lt. W. R. Limburg of Rome Air Development Center, summarized the present state-of-the-art in their paper "Loss of System Effectiveness Due to Electromagnetic Interference." Here are conclusions based upon their past year's experience:

The method of evaluating (a) system receiver under controlled laboratory conditions using known intensities and selected types of interference appears to be a sound approach to quantitatively determining the effects on system performance.

The state-of-the-art in quantitatively determining the decrease in system performance due to interference must be advanced if analysis and prediction outputs are to be fully utilized.

Of the several methods available to evaluate the performance of speech systems, the two machines, Voice Interference Analysis Set (VIAS) developed by General Electronic Labs., and Speech Communication Index Meter by Bolt, Beranek and Newman, Inc. (SCIM), appear to be best suited for use in interference tests. Further tests using additional types of interference must be conducted to compare VIAS and SCIM performance with that of the talker-listener panel. Both VIAS and SCIM appear to give rapid and repeatable results.

To properly evaluate system effectiveness under interference conditions a need exists for system performance criteria, for standardized definitions of measurement terms, and for improved measurement techniques and equipment.

F. J. Nichols' paper, "A National Policy for Electromagnetic Compatibility" puts the finger right on one of the increasingly-serious problems in prediction. "Our EMC problems," he said, "become more complex by several orders when we go from the system to the inter-system problems, and it is in the inter-system area that we usually come into contact with present and future utilization of the RF spectrum, frequency allocations, types of modulation, etc., as we find that many phases of our EMC problems are really in the hands of others." "In the hands of others" describes a situation which will not be easily corrected since the military naturally feels that defense responsibilities come ahead of civilian activities and, hence, their use of the spectrum and accompanying power requirements have to be included in any prediction efforts. This requires a "safety margin" to be included in any prediction data. Boeing's paper, "Evaluation of System Electro-compatibility" clearly states the situation:

"MIL-E-6051C requires a safety margin such that any interference signal impressed on a sub-system must be at least 6 db below that level which would produce an undesired response in the functioning of any part of the sub-system. However, a method of demonstrating compliance should not be limited to a 6 db margin of safety. If malfunction of a sub-system can produce a severe flight or launch hazard, it may be necessary to demonstrate a higher margin of safety. In general, rapid assessment of detected results or an immediate GO/NO-GO indication of whether the system meets the 6 db (or other) requirement is the optimum goal of a system test."

"An important aspect of showing a safety margin is accuracy. Errors may be introduced whenever test equipment is connected to the system. Consequently, the amount of test cabling and connections associated with a given test plan should be held to a minimum. Furthermore, any device connected to a point in the sub-system must be chosen so as not to affect its electrical characteristics."

PROTECTION FROM SHORT PULSES - Control and suppression of harmful transients received more attention at this Conference than at any previous meeting. E. Haber and L. Jambor of General Dynamics/Astronautics presented a paper titled "Analytical Prediction and Suppression of Inductively Caused Transients" which discussed one reason why harmful transients now receive more consideration. "Operation of inductive devices in electronic systems causes harmful transients which can couple throughout the system via conduction, induction and radiation," their paper stated. According to the authors, most complex electronic devices are susceptible to these transients. They point out that digital circuits are permanently damaged because breakdown voltages of solid-state components are exceeded; others, such as sensitive receivers, can be temporarily degraded due to electromagnetic interference. These voltage and current transient problems, Haber and Jambor observed, are common in the aerospace industry where the majority of the components that comprise a system are operated from a common power supply altho' most problems are readily recognized by designers who are aware of radio interference. Techniques usually employed for suppression are "brute-force" networks they say, such as LC filters, simple RC networks, or just a back-biased diode with a limiting resistor across the coil. "Of all these methods, probably the most widely used is the diode-resistor," say the authors.

W. D. Hayter, IBM, San Jose, Calif., in his paper "High Voltage Nanosecond Duration, Power Line Transients" discussed three years of work in this field. Interruption of inductor current on power lines produces a limited pulse main, he said, which can have pulse repetition rates as high as 20 Mc/s, amplitudes as high as 1000 volts, durations as short as 10 nanoseconds, rise times as fast as 2 nanoseconds, and a train length as long as 3 milliseconds. Transient transfer from the transient producing device to a digital device is via power lines which act as multiwire eccentric transmission lines, Hayter pointed out. Power lines outside of conduit act as multiwire unbalanced transmission lines, and at the junction of open wire and conduit pulses are induced which flow on the outside of the conduit. These pulses are normally called "conduit waves." Multiple reflections of transients in power lines cause addition and subtractions to produce "power-line resonance," the author continued, and transfer from the power cord to the digital device is by line-to-line pulses coupling through the power supply and line-to-ground plane pulses coupling to the frame. These pulses, under the right conditions, cause digital equipment to malfunction, according to Hayter, who went on to describe the design of a transient simulator which forecasts a digital system's performance in a normal transient environment.

Hoffart and Ball, in their previously-mentioned paper, referred to the intensities of lightning storms referenced two reports which showed that the Florida area has the highest incidence of lightning storms in the continental limits of the United States. Here, they said, lightning voltages and currents can be as high as 100 million volts and 180,000 amperes, and recent investigations show that the average current is in the order of 40,000 amperes. In addition, the high potentials and high currents do not necessarily occur simultaneously.

SUMMING-UP - If and when Senate Bill 2684 passes (see inset, page 11), there will undoubtedly be a multitude of industrial efforts to create standards and limits for every product and device. This should tend to increase the public demand for a national policy on EMC into which individual compliances would fit. In discussions about this at the Conference, several people felt that a great deal of thought should be given to this whole subject since excessively-tight or restrictive standards and limits might tend to retard future development work on adoption of more advanced techniques. Although they conceded the desperate need for a national policy, there was some doubt as to just how many qualified people were available who possess experience on both the theoretical and practical sides. If the standards and limits were entrusted to scientists, they would probably not be practical; yet, on the other hand, if only one type of engineer was selected, other impracticalities might turn up since R&D engineers, development engineers, production engineers, and test engineers all have something to offer. What do you think?

ELIMINATING MOBILE NOISE

Communications Publishing Corp., P. O. Box 63992, Oklahoma City 6, Okla. has published a technical handbook that explains how to denoise your automobile. The price is $1.95.

FACILITIES AND TECHNIQUES FOR THE ANALYSIS OF ELECTROMAGNETIC COMPATIBILITY AND SUSCEPTIBILITY OF NAVAL AIRCRAFT WEAPONS SYSTEMS

J. V. LeFort and R. S. Pugh, Naval Air Test Center, Patuxent River, Md., delivered a 10-page paper on the above subject with an additional 10 pages with 20 figures showing test set-ups, test conditions and test environments. The abstract of the paper is as follows:

"Abstract - This paper discusses the facilities and techniques for the conduct of Electromagnetic Compatibility and Environmental Electromagnetic High Intensity RF Field Susceptibility Analysis of Naval Aircraft Weapons Systems and Associated Support Equipment at the Naval Air Test Center, Patuxent River, Md. The test facility consists of an Interference Test Laboratory (shielded hangar) capable of housing the largest aircraft. The controlled laboratory provides very low ambient electromagnetic fields which affords precise compatibility analysis. For the environmental tests, electromagnetic fields are generated and contained within the controlled area. Analyses are in conformance with applicable specifications which are supplemented with current state-of-the-art techniques. Many new and complex weapons systems have been created with resultant solid state devices, i. e., computers, etc., and receivers having exceedingly high respective susceptibilities and sensitivities which require simultaneous operation with communication systems, data systems, and radars of high intensity RF power output. The need of controlled areas and improved techniques for precision analysis of these weapons systems to provide valid results and corrective applications has become increasingly important."

Copies of the paper may be obtained by writing to the authors.

PANORAMIC CAMERA PAPER AVAILABLE

A. L. Albin, Fairchild Space and Defense Systems, 300 Robbins Lane, Syosset, L. I., New York 11791, has made available his paper given at the Tenth Tri-Service Conference in Chicago titled "Interference Suppression of a High Performance Transistorized Panoramic Camera (KA-60)". The abstract of the paper is as follows:

"Abstract - This paper describes the interference control measures incorporated in the KA-60 panoramic camera to assure compliance with MIL-I-26600 and MIL-E-6051. Each sub-assembly was designed as an integrally interference-suppressed unit for conducted interference. The camera body, magazine and control units were designed as shielded enclosures to obtain greatest reduction of radiated interference and susceptibility. Use was made of transistor-driven relays to reduce transients. A unique miniaturized filter network of postage stamp size was designed and fabricated, providing high attenuation at low frequencies for low current applications."

ONAN BRINGS OUT SPECIAL REPORT ON GENERATOR SUPPRESSION

ONAN, Division of Studebaker Industries, Inc., 2515 University Ave., S. E., Minneapolis, Minn. 55414, has brought out a special report of 18 pages titled "Radio Frequency Interference." The report goes into quite some detail on the suppressing of RFI on ONAN generating equipment to all available government specifications including Canadian. Copies of this extensive report may be obtained from Virgil C. Gilbertson, Mgr., Product Publicity at the above address.

DESIGN GUIDE FOR ELECTRONIC-OPTICAL SYSTEMS

Lawrence K. Anderson, Supervisor, Microwave Devices Group, Bell Telephone Labs,, Murray Hill, N. J., has an 8-page article under the above title in the January 1965 issue of Microwaves. Much of the information in this article will explain some of the data on the above chart. The sub-title and first paragraph are as follows:

"Broadband modulation of lasers is now entirely practical. Three basic approaches and several variations are described and compared. Newest among these are a potassium tantalate niobate modulator, several extended designs and free carrier absorption devices.

"An optical carrier can be modulated by techniques which are extensions of familiar, low-frequency methods:

"modulation of the oscillator drive
"modulation by variable reactance
"modulation by variable absorption

"The electro-optic effect is the best example of modulation by variable reactance and it will be discussed first since most practical light modulators are based on that effect in solids."

EVALUATION OF RF NOISE MEASUREMENTS FOR DIODE RELIABILITY IMPROVEMENT BY ELIMINATION OF WEAK UNITS

L. Kirvida and C. Maronde, Honeywell, Inc., Minneapolis, Minn. presented a 20-page paper, with the above title, before the Third Annual Symposium on the Physics of Failure in Electronics, Chicago, Illinois, October 1, 1964. The Abstract and first five paragraph of the Introduction are:

Abstract

"The noise characteristics of a general purpose silicon diode (type IN645) were studied to determine whether excessive RF noise can be correlated with high failure rates. Noise measurements were made at 25 mc, while impacts within the rated values were applied to aggravate potential structural imperfections. The purpose of the test was to remove the unreliable distribution of diodes from the sample tested. Photographs of the etched cross-sections of several diodes typical of those isolated by the noise test are included. Causes of RF noise in silicon p-n junctions are discussed. Life testing to determine the correlation between abnormal noise and early failure is under way, but the results are not available at the time of this writing. However, the results of the life test will be available in time to be included in the publication of the Symposium Proceedings."

Introduction

"Recent demands for high reliability and minimum redundancy pose a frustrating delemma for circuit designers. As one possible solution to this problem would be to lower the failure rates of the components used, non-destructive testing techniques have been given greater emphasis.

"The purpose of this paper is to explore the feasibility of using RF noise as a tool to predict early failure; the supposition being that physical abnormalities within a component will cause a higher than normal RF noise level.

"Honeywell began investigating RF noise detection as a method of fault isolation several years ago. This technique was examined as a result of high noise spikes occasionally observed during the course of RF interference tests required for military equipment. Further study revealed that the noise spikes resulted from intermittent faults within the equipment.

"Experimentation was conducted for two years on gyro sensors, temperature and guidance control amplifiers, and timers, to conform that the noise spikes result from an intermittent type fault or a defect in the unit under test. During this period, it was discovered that the sub-assembly occasionally required mechanical shock to aggravate the incipient failure to make it show up by means of RF noise measurements. When a defective sub-assembly was detected, the faulty component was located by tapping each component on the board with a phenolic rod to determine which one produced noise.

"Contract AF30(602)-3258, under which the present work was done, was awarded Honeywell by RADC to study the relationship between RF noise and early failure of a silicon diode (IN 645) and a tantalum capacitor. The results of our study on the silicon diode are covered in this paper. The work to be discussed here is divided into three areas of endeavor:

"1. The testing or screening of the diodes to segregate those exhibiting an abnormally high ambient RF noise level.

"2. A Theoretical investigation into the mechanisms of failure involved in the generation of RF noise by the diode.

"3. Life test to substantiate the premise that noisy diodes have a high failure rate."

Copies of the paper may be obtained by writing to: Leonard Kirvida, Sr. Research Engineer, Scientist, Minneapolis Honeywell, 2600 Ridgway Road, Minneapolis 40, Minn., Mail Station 340.

ITEMS OF INTEREST IN IEEE SPECTRUM, JANUARY 1965

The above publication contained the following items of interest:

On page 138 - from IEEE Transactions on Information Theory Vol. IT-11, No. 1, January 1965.

The Subjective Effect of Two-Dimensional Pictorial Noise, T. S. Huang -

"A study has been made of the subjective effects of the class of independent additive rectangular low-pass Gaussian noises. Three original pictures, varying in the amount of detail, were used. The general shapes of the isopreference surfaces in $\sigma - k_1 - k_2$ space where σ is the rms value, and k_1 and k_2 are the bandwidths of the noise in the horizontal and vertical directions, respectively, were found. If the objectionability of noise is a linear functional of the noise spectrum then one may deduce that for the class of noises whose spectra are symmetrical with respect to both horizontal and vertical frequencies, the weighting function in the integral representing noise objectionability is similar in shape to these isopreference surfaces."

On page 139 - from IEEE Transactions on Information Theory Vol. IT-11, No. 1, January 1965

Nonparametric Detection of a Signal of Known Form in Additive Noise R. F. Daly, C. K. Rushforth -

"The problem of detecting a signal of known form in the presence of additive noise whose distribution function may not be known is treated. Two detection schemes are considered, one for a signal which is known exactly and one for a signal with unkown phase. Using the criterion of asymptotic relative efficiency (ARE) the performance of each detector is compared with that of the corresponding detector which is optimum for Gaussian noise. It is shown that for detecting a known signal, the ARE of the nonparametric detector relative to the correlation detector is equal to one if the noise is Gaussian, and is strictly greater than one any continuous non-Gaussian noise distribution. An identical result holds for the ARE of the nonparametric detector for a signal with unknown phase that is relative to the standard envelope detector."

On page 141 - from IEEE Transactions on Space Electronics & Telemetry, Vol. SET-10, No. 4, December 1964

Magnetic Fields Near Twisted Wires, A. Y. Alksne -

"Formulas are given for the field near twisted leads carrying equal and opposite direct currents, and results are plotted in dimensionless form for various cases. It is shown that, at some points, twisting the wires may result in strengthening rather than weakening the field."

AUTOMATIC ELECTROMAGNETIC SPECTRUM SCANNING AND PLOTTING

The above is the title of a Technical Bulletin, Vol. 4, No. 4, of October 1964, published by White Electromagnetics, Inc., 670 Lofstrand Lane, Rockville, Md. The Bulletin is 4 pages and describes the operation and system characteristics of their Model 120A Auto-Spectrum Plotter. Copies may be obtained by writing directly to White Electromagnetics.

HONEYCOMB GIVES RFI THE BEESNESS

Electrical Design News, January 1965, contains an article with charts by J. A. Rose, Western Editor, under the above title. The first three paragraphs are as follows:

"Metal honeycomb materials, afford radio-frequency (RFI) shielding while accommodating transmission of light and air. Well-known for its use in structural applications, the electrical continuity of foil ribbons and regular pattern permits the use of honeycomb as an effective RF shield. The shielding frequency is determined by the cell size and material used.

"For comparison, a honeycomb structure of 0.002-inch foil with 1/4-inch cell size will attenuate to 86 db. An equivalent thickness of steel plate would be 0.058 inch and aluminum plate would be 0.26 inch thick.

"The shielding properties of metal honeycomb operate in two general modes. At higher frequencies honeycomb can be considered as a set of parallel wave guides. The critical cut-off wave length is twice the honeycomb cell width, measured across the flats of the cell. The attenuation is determined by the thickness of the honeycomb structure."

ACADEMY AMPLIFIES ENGINEERS' VOICE

Under the above title, Electronics, January 11, 1965, carried the following from in its Washington Newsletter column on page 62:

"The electronics industry is expected to have a stronger voic in shaping federal science and research policies with the establishmen of the National Academy of Engineering.

"The academy was created in response to objections by engineers that fewer than 10% of the 600 members in the National Academ of Sciences are engineers. One of its principal functions is to advise the government.

"Members of both academies represent industry, schools an nonprofit research organizations. About half of the National Academy of Engineering's founding members represent industrial companies, many of which have a stake in electronics."

EDITORIAL NOTE

The lack of engineering advice in many government decisions has worried the engineering profession for some time and comments on this situation have been made several times in this Newsletter. The EMC engineer is still an inaudible minority in many engineering decisions and he will probably share the same fate in the National Acaden of Engineering if a concerted effort is not made by all of us to get better recognition.

CLEARINGHOUSE OPEN FOR GOV'T RESEARCH

Metalworking News, Dec. 21, 1964, carried the following news item:

"Washington - A Clearinghouse for Federal Scientific and Technical Information has been established in the Commerce Dept. t serve as the control source for Government research data in the physical sciences and engineering.

"It has also taken over the document distribution program of the Office of Technical Services.

"Endorsed last February by the Federal Council for Science and Technology, an advisory body to the President, the Clearinghouse will serve as the single agency through which unclassified technical reports and translations generated by all Government agencies will be indexed and made available to the public.

"The Clearinghouse is a part of the new Institute for Applied Technology in the National Bureau of Standards. The Institute is headed by Dr. Donald A. Schon, formerly of Arthur D. Little, Inc., Cambridge, Mass. The director of the Clearinghouse is Bernard M. Fry, formerly with the National Science Foundation and the Atomic Energy Commission.

"In addition to providing research information to industry, the Clearinghouse is designed to reduce duplication in both industry and Government in research and information processing. According to Dr. Schon, savings to the Government of about $500,000 will be realized during the first year of operation as a result of reducing duplication of document and distribution within the Federal establishment.

"A major step in this direction was a recent agreement between the Commerce Dept. and the Dept. of Defense whereby the Clearinghouse assumed the task of processing all unclassified, unlimited DOD research reports, as well as reproduction and distribution of these documents to both the public and DOD agencies and contractors."

THE BACKWARD DIODE - WHEN AND HOW TO USE IT

Microwaves, Dec. 1964, carried a 5-page article by Russell O. Wright, Project Engineer, Philco Corp., Lansdale, Pa., under the above title. The sub-title and pertinent excerpts are as follows:

"Low noise and high reliability distinguish this new class of microwave semiconductors. With units operating into Ku band now available, their use as detectors and mixers merits greater attention by the microwave designer.

Amplifier Noise

"Since the NR_o of backward diodes is nearly unity, it is particularly important to reduce the NF_{if} term in Eq. 1. Of course, this is also true with point-contact diodes, but in low IF systems the NR_o of point-contact diodes swamps the NFif which therefore does not contribute significantly to NF_o. Greater attention to amplifier design is necessary to realize the inherently low NF_o of the backward diodes. This is often overlooked when specifying backward diodes for existing systems."

"The local oscillator klystron must be a low noise type designed for doppler systems (preferably a double-cavity type). If frequencies of about 20 Kc or higher are used, a high-Q filter can be added to eliminate the klystron noise sidebands at the IF frequency. If this precaution is not taken, the klystron noise will enter the IF system as apparent diode noise and will degrade performance. This is another factor that has not been carefully considered in low IF systems that use point-contact diodes, since these diodes often swamp the klystron noise. However, in any system operating down to 1 Kc, klystron noise must be considered (and especially with backward diodes) if optimum results are to follow.

"The noise tube simulates the incoming receiver signal and generates a precisely known signal level. However, suitable isolation must be included. Otherwise, reflected LO power will be modulated at the low IF frequency by the gas discharge in the tube and will re-enter the system as an apparent high-level signal thus giving optimistic readings."

DESIGNING THE RFI SHIELDED PACKAGE

Electronic Industries, Jan. 1965, carries a 4-page article under the above heading by Arnold L. Albin, Fairchild Space and Defense Systems, Syosset, L.I., New York. The sub-title and opening paragraphs are as follows:

"When designing an RFI shielded electronic package, certain questions must be answered. What material should be used? Should shielding and filters be installed? How should the seams, joints, etc., be designed? These and other pertinent questions are answered here.

"There are three basic problems to be considered in designing the shielded electronic package. The material to be used and its thickness should be determined. The seams, joints, meter openings, and other apertures should be designed so as to reduce leakage. And, shielding and filters should be installed to block interference on interconnecting cables.

"In this article, we will show the design approach which was used to achieve shielding in a representative package.

"Designing shielded equipment is not hard if the basic means by which interference enters or leaves the equipment is understood. (Consider interference to be any undesired radiation which exceeds certain specified levels.) Shielding will confine the interference and prevent escape of r-f energy from the enclosure. Shielding may also reduce the influence of external fields.

"A perfect shield is not possible. What factors permit interference to escape from an enclosure? Power lines are an important source of interference because of the direct connection to internal devices. Control leads also are often connected to interference sources. Holes for component mounting, and joints in the equipment case, also provide a means of escape for an interference signal. Attentuation of the signal through the material of the case itself may sometimes be less than through these alternate paths."

NOISE MARGINS IN DIGITAL INTEGRATED CIRCUITS

Under the above title, a 7-page article appeared in the Dec. 1964 issue of the Proceedings of the IEEE by Gerald Luecke, Semiconductor Components Division, Texas Instrument Inc., Dallas, Texas. The Summary and first three paragraphs of the Introduction are as follows:

"Many integrated circuit logic gates, especially the complete monolithic type, operate at very low signal levels. For this reason, the sensitivity of such circuits to noise is very important. The general definition of noise margin leads to a discussion of dc and ac noice margins for a simple inverting gate, and specific test data of an RCTL gate. A standard definition for input ac noise margin for a simple logic gate is proposed.

"When binary levels are used in a simple logic gate for transmission of data in digital form, then logical levels are chosen to represent the bits of information, 'ONE', or 'ZERO.' These levels can be either voltage or current; however, in present-day integrated circuits, they are usually voltage levels.

"If now we choose the functional diagram of Fig. 1 to represent the simple logic gate, we see that we have an input terminal (usually there are several input terminals of the same kind) to excite the gate, an output terminal to feed other gates, a supply voltage terminal, and a reference voltage terminal; in this case, ground. A change of state of the output indicates that the input has been excited.

"We can make several statements about these voltages. The supply and reference voltage, of course, should be held constant within given operating design tolerances. The output voltage, in order to indicate the bits of information to succeeding gates that it feeds, must be at either the ZERO or the ONE level. The input voltage is the excitation that determines the output voltage level. The logical relationship between the input voltage level and output voltage level depends on the gate design. Either the output level is at the same logical level as the input or it is the inverse of the logical input level."

THE ELECTRICAL ACTIVITY OF THE NERVOUS SYSTEM

Science, Dec. 11, 1964, carries a 6-page article under the above heading by Prof. Mary A. B. Brazier, Brain Research Institute, University of Calif. at Los Angeles. The sub-head and first two paragraphs are as follows:

"Electrical signals are the neurophysiologist's clue to coding in the nervous system.

"The single most important discovery in the exploration of nervous mechanisms was that the nerve impulse is identifiable with an electrical change. The electrical sign of activity has given the investigator a means of studying the functioning nervous system - a tracer by which he can follow impulses in the living organism through the complexity of structure that the microscope can reveal only in dead tissue. It is also the only clue he has as to how messages may be coded in the nervous system.

"But it was not in the whole organism that the pioneers made the first observations, nor their followers the analyses of the basic characteristics of nerve action. It was from the most readily accessible nervous structure, the large peripheral nerve trunks of an animal's limbs, that this fundamental knowledge was first acquired. The fact that these nerve trunks, themselves

formed of numbers of parallel nerve fibers, could retain their function for a limited time if maintained in a moist atmosphere set the experimental pattern for all the early workers; only much later were techniques developed for recording the electrical activity of the nerve in vivo."

MICROVIBRATIONS IN MAN AND DOLPHIN

Science, Nov. 27, 1964, carries a 2-page article under the above title by Manfred Haider and Donald B. Lindsley, Dept. of Psychology & Physiology, University of California, Los Angeles. The abstract and first paragraph are as follows:

"Microvibrations were recorded from the dorsal body surface of a bottle-nosed dolphin (Tursiops truncatus) while it swam in water and while it lay on a foam rubber mattress in an air environment. Unlike poikilothermic water-living animals which do not manifest microvibrations, this homeothermic mammal has 13-cycle per second microvibrations similar to those of man and other homeotherms. For comparative purposes, microvibrations' of 11 cycles per second were recorded from the arm of a man while lying on the same mattress. The nature and origin of these microvibrations is discussed in relation to physiological tremors and shivering.

"Fine, tremor-like vibrations, invisible to the human eye, which occur at all times over the entire body surface of warm-blooded animals, have been studied extensively by Rohracher. These have been referred to as microvibrations and minor-tremor. In relaxed, awake humans the amplitude of the microvibrations ranges from 1 to 5 μ. During sleep their amplitude is greatly reduced, and during muscular activity it is enhanced. Interruption of the motor innervation to a given body part results in almost complete disappearance of microvibrations in that area. Because of these characteristics, there has been a tendency to associate microvibrations with processes underlying muscle tonus. The frequency of microvibrations in humans ranges from 7 to 13 cy/sec., values which are comparable to those of fine, finger tremors, 'physiological tremors,' the grosser tremors of shivering, and to the alpha rhythm of the electroencephalogram. However, the lack of an exact correspondence between finger tremors and alpha waves over the motor area of the brain led Jasper and Andrews to conclude that they were not interdependent. Also, it seems unlikely that there is any close correspondence between body microvibrations and alpha waves, since the latter vary in frequency and phase over different regions of the head."

METAL-OXIDE-SEMICONDUCTOR FIELD-EFFECT TRANSISTORS

Electronics, Nov. 30, 1964, carries a 12-page article under the above title by Frederic P. Heiman and Steven R. Hofstein, RCA Labs. Radio Corp. of America, Princeton, N. J. Paragraphs of interest are as follows:

"Low noise - The field-effect transistor is a majority-carrier device and the shot noise usually associated with minority-carrier current flow in a bipolar transistor is absent. However, there is a shot-noise component present in the noise spectrum of experimental devices. The main source of noise at high frequencies in field-effect transistors is thermal noise due to random fluctuations in the channel free carrier concentration. Noise figures comparable to low-noise vacuum tubes are obtained at frequencies above 50 Mc.

"The low-frequency noise spectrum, which may extend up to tens of megacycles per second in some devices, is controlled by fluctuation in the number of electrons occupying surface traps and resembles an f^{-n} distribution. The value of n is generally between 1 and 2, and the spectrum extends down to very low frequencies. At present, considerable research is being devoted towards a better understanding of the semiconductor surface, and an improvement in the low-frequency noise performance of these devices is likely."

ULTRASONICS PINPOINTS ARCING, CORONA

Insulation, Dec. 1964, had the following news item under the above heading:

"The city owned utility of Tacoma, Wash., uses an ultrasonic detection system to locate trouble spots which may result in radio and TV interference such as might be caused by arcing on 52. 5, 105, and 230 kv lines. The unit 'listens' for sonic energy in the 36,000 to 44,000 cps range which is far beyond human hearing and ambient masking noises. The Delcon detection unit translates ultrasonic energy into immediately recognizable audible counterpart sounds. Since corona sounds are familiar to all utility service men and normal eye/hand coordination can pinpoint the source of the energy, training requirements are said to be minimal. Usable from ground level at distances up to 60 feet, the portable detector can pinpoint a faulty insulator from among a cluster of seven, and from 8 to 10 foot distances."

HOW TO MEASURE FET NOISE

Electronics, Nov. 30, 1964, carries a 2-page article by Joel M. Cohen, Director of Engineering, Crystalonics, Inc., Cambridge, Mass The sub-title and the first three paragraphs are as follows:

"New method allows calculation of noise voltage at any source impedance.

"An important consideration in the selection of components for oscillator or amplifier service is the amount of noise that a device contributes to the total circuit noise.

"The widespread use of such low-noise devices as field-effect transistors has increased the difficulty of measuring noise and encouraged an overhaul of the standards of noise measurement.

"The most widely used standard of noise measurement for semiconductor devices is noise figure - defined as the ratio of the signal-to-noise power ratio at the input to that at the output. However, this standard goes back to the days of the noisy vacuum tube when the absolute sensitivity of the amplifier was of paramount interest, and comparisons of the relative merits of various amplifiers were significant. Now circuit designers need data that is meaningful and useful for circuit design as opposed to a noise figure that is useful simply as a method of comparison, but has no meaning in itself when the conditions under which it is measured are not considered."

TRANSIENT ANALYTICAL SYSTEM TO DETECT PULSE DAMAGE

Walter Andrews has a page article in Electronic News, Jan. 25, 1965, under the above title. The first five paragraphs are as follows:

"Westbury, N. Y. - Missile failures due to transient pulse damage makes the detection and recording of these high-speed, non-repetitive pulses a necessity - so that their source may be eliminated and the electronics of the system protected.

"General Applied Science Laboratories here says it can do this job with its new Mark II transient analytical system.

"The system, according to Richard S. Rothschild, Manager of Electronic Products, will obtain waveshapes of non-repetitive, single nanosecond electrical events, and supply all the required data in electronic form essentially simultaneous with the transient.

"Mr. Rothschild said the measurement of a transient having a risetime of 0. 33 nanoseconds is possible with the new system down to a noise level of 1 millivolt.

"The heart of the modified sampling system, he said, is a number of fast sample and hold circuits, whose outputs are in the form of voltages proportional to the signal voltage at each sample time."

DYNAMIC NOISE GENERATION IN REED SWITCH CONTACTS

Electronic Industries, Dec. 1964, carries a 4-page article by Jack J. Vitola, Senior Project Engineer, and John P. Breickner, Project Assistant, Wneelock Signals, Inc., Long Branch, N. J., under the above title. The subhead and first two paragraphs are as follows:

"Since reed switch noise voltages are now being specified for reed relays, a means of minimizing this noise is sought. But, before this is done, how and why reed switches generate this voltage must be investigated.

"Operation of the contacts in reed relays generates a dynamic contact noise which is peculiar to this type of switch. With the growing use of reed relays in low level applications, any form of dynamic contact noise becomes very significant.

"This switch illustrates noise characteristics of miniature reed switches and presents an introduction to the theoretical considerations of the mechanisms present. This allows a better understanding by the designer and user of reed switching devices."

S AND X BAND DIODES YIELD LOW NOISE

Electronic Design, Dec. 7, 1964, carries a one-column discussion under the above heading. The first two paragraphs are as follows:

"Noise figures of 5. 5 and 6. 5 db, in the S and X bands, respectively, are reportedly attained by a pair of point-contact silicon mixer diodes.

"Developed by Sylvania's Semiconductor Div., the units are said to achieve noise figures 0. 5 db under those obtainable in other currently available microwave diodes. This improved noise figure, according to Sylvania, may eliminate the need for parametric and tunnel-diode amplifiers in some applications."

DESIGNING WITH LOW-NOISE MOS FETs: A LITTLE DIFFERENT BUT NO HARDER

Electronics, Dec. 14, 1964, carries a 5-page article under the above heading by Georg G. Luettgenau and Sanford H. Barnes, TRW Semiconductors, Inc., Lawndale, Calif., a division of Thompson Ramo Wooldridge, Inc. The subtitle and first two paragraphs are as follows:

"Devices are being applied in many different circuits. Here are nine designs in the communications field.

"The insulated-gate metal-oxide-semiconductor field-effect transistor (MOS FET) lends itself to a variety of circuits applications. Although the MOS device has been commercially available less than a year, it has already been successfully used in audio amplifiers, r-f amplifers, mixers, product detectors, oscillators and for many other applications.

"To acquaint the circuit designer with MOS FET circuitry, several typical circuits are presented in this article."

LOW-NOISE FETs SOUND GOOD TO CIRCUIT DESIGNERS

Electronics, Dec. 14, 1964, carries a 5-page article under the above heading by Bruce Smith, Crystalonics, Inc., Cambridge, Mass. The subtitle and first three paragraphs are as follows:

"Added interest in new field-effect transistors spurs new ways to design for low noise in amplifiers.

"Circuit designers, intrigued by the low-noise capability of the field-effect transistor, are finding a variety of applications for this semiconductor device. Among the most important are audio and radio-frequency amplifiers.

"The heightened interest in new field-effect transitors has prompted manufacturers to reconsider their methods of specifying noise.

"An ideal amplifier does not add any noise to the signal. But in any practical amplifier, the noise at the load contains contributions by both the source and the amplifier, itself."

NOISE FROM A HOT RADOME

IEEE Spectrum, Dec. 1964, page 5, under the above heading carries an advertisement by the Airborne Instruments Lab., Deer Park, Long Island, N. Y. The subtitle and first paragraph are as follows:

"A few years ago, hot radomes and frigid receivers were rarely discussed. Times change and a 0. 675 degree K. noise temperature of a radome may be of consequence to some readers of this ad. This month's contribution was prepared by Dave Fink and Ralph Logan of our Aerospace Department.

"The advent of high-speed missiles and re-entry vehicles has brought about many new and interesting problems. One of these problems is the noise created by the elevated temperatures of the radome. To estimate the order of magnitude of noise emission from a hot radome into an antenna, a simple example can be examined. Let us say we have an infinite flat dielectric sheet, with a circularly polarized antenna a distance r behind it."

WASHINGTON NEWSLETTER

Electronics, Dec. 28, 1964, under the above heading has the following news item. The subtitle and first four paragraphs are as follows:

"Can foe stymie U. S. missiles?

"Judging by the projects in the works, the Defense Dept. is becoming increasingly worried that United States weapons could be immobilized by electronic methods. Here are some ways the U. S. is combatting the danger:

"The Air Force plans to study ways of inducing large electromagnetic fields in the ground. The aim is to simulate the electromagnetic pulse resulting from a nuclear detonation. Though defense officials are tight-lipped about the project, it appears that they want to explore the effects of a ground nuclear blast on hardened missile sites.

"The Navy is planning to investigate ways of increasing the resistance of torpedo homing systems to acoustic counter measures. A major industry study is in the offing, including the construction of laboratory equipment, devices and breadboard circuits.

"And the Army is requesting proposals for a study to determine the vulnerability of the Nike-Hercules missile system to electronic countermeasures. The system, which includes high- and low-power acquisition radar, missile-tracking radar and target-ranging radar, is designed to shoot down enemy tactical missiles."

A NEW USE FOR THE OSCILLOSCOPE: MEASURING SIGNAL-TO-NOISE RATIO

Electronics, Dec. 28, 1964, carries a 6-page article of interest under the above heading by J. W. Eberle, Dept. of Electrical Engineering, Ohio State University, Columbus. The subtitle and first three paragraphs are as follows:

"Measurements with a new technique are as good as the observer's ability to determine the point of peak intensity of a displayed waveform.

"The most common way of evaluating the quality of a communication channel, or a portion of it, is in terms of the signal-to-noise ratio. But, because of the random nature of noise, it is extremely difficult to make signal-to-noise ratio measurements. At some point in the measurement process, a statistical approach in which a mean or mean-square value is sought, is necessary.

"Most laboratory instruments are designed for use with sinusoidal waveforms. The specific instrument used determines the technique for the measurement of noise and the interpretation of the results. This can lead to confusion among engineers when a signal-to-noise measurement is required.

"To overcome this, a method has been developed that uses an oscilloscope to measure signal-to-noise ratio. Only a basic understanding of the statistics associated with noise is required to make SNR measurements of reasonable accuracy. The accuracy of the measurement depends on the observer's ability to determine the point of peak intensity of the displayed waveform."

DESIGNING AGAINST SPACE RADIATION: PART I

Electronics, Dec. 28, 1964, carries an 11-page article of interest under the above heading by Henning H. Lind Olesen, Re-entry Systems Dept., General Electric Co., Philadelphia. The subtitle and first six paragraphs are as follows:

"More and more electronic systems are being sent through space. Engineers used to know the radiation environments these circuits must withstand.

"The space age has confronted electronics engineers with some new words and concepts: trapped radiation, albedo protons, solar x-rays, ionization effects, fast neutrons, rads, dose rates and many more.

"Planning for space vehicles that must withstand radiation exposure has introduced a new environment with which the engineer must become familiar.

"Over the years, the engineer has learned to use semiconductor devices and components to reduce size, weight and power consumption. As experience with nuclear radiation has increased, it has become apparent that it affects these components drastically. Nuclear radiation has had an even greater effect on transistors than on the vacuum tubes that they replaced.

"The most obvious solution - shielding - is often impossible because it adds too much wieght.

"To design against nuclear radiation, the engineer must know how radiation affects materials and circuit elements, and how some design techniques can avert some problems.

"Part one of this article will describe nuclear environments and the interaction of radiation with the material atomic structure. In the next issue, part two will describe how this affects electronic components, and radiation-hardened circuit design techniques altogether with some design examples."

SPACE VEHICLES TO BE PROTECTED FROM LIGHTNING

Electronics, Nov. 16, 1964, has the following article describing space vehicle protection at Cape Kennedy. The article, Lightning Watch, is as follows:

"Scientists at Cape Kennedy are using an electronic sky scanner to alert them that a thunderstorm may be brewing. The aim is to protect both space vehicles and themselves from lightning.

"Bolts of lightning can cause havoc in areas of sensitive electronic missile equipment and explosive fuels. And thunderstorms are common at the Cape.

"Weathermen at the missile area are experimenting with a set of atmospheric interference detectors (sferics) to monitor sudden build-ups of electromagnetism. Such buildups signal the possible birth of a thunderstorm.

"The detection system, called Sparsa--for sferic pulse amplitude rate spectrum--was developed by D. A. Kohl of Litton Industries, Inc., Applied Sciences Div. (Electronics, May 18, p. 27).

"The instrument monitors the area within 200 miles of the missile center.

"A tip that a storm is brewing alerts the missile men to batten down the hatches and tuck a poised missile inside a hangar if there is time.

"The instrument comprises three station. The main one is at Patrick Air Force Base, some 15 miles south of the Cape. Another is at the Bithlo, 25 miles to the west, and the third is at Ponce de Leon Inlet, about 45 miles up the coast.

"East station has four antennas mounted on a single turntable. With a bit of calculation, messages from the three stations can pinpoint an electromagnetic buildup and its path can be traced.

"The outputs of the four antennas and their receivers are measured by an automatic control circuit. The turntable remains stationary if there are no sferics signals present. If sferics signals are detected above a preset level, the control circuit causes the turntable to scan in steps of 5.625 degrees per step. The turntable holds for 10 seconds after each step, and then rapidly recycles back to the initial position upon completion of the eighth hold position.

"Scanning continues as long as the omnidirectional sferics output exceeds the threshold.

"Data remotely monitored. Data from the two remote sites is fed over phone lines to the main station at Patrick. All the data is then fed to a processor along with the readout from a weather radar, which is used to provide direction, range and height data on clouds.

"At the main station, the output from each Sparsa station is displayed on cathode-ray tubes that are monitored by vidicon cameras. The vidicon signals are mixed and shown on a 21-inch television screen with a map overlay of the area.

"Only a warning. Weathermen are hopeful of getting up to two hours warning of impending electrical storms--plenty of time to remove workmen from missile gantries, disconnect umbilicals and secure all ground-support equipment.

"But the two-hour warning isn't good enough. It takes three and a half hours to move a Saturn V moon rocket back to a vertical assembly building from a launching pad, so development of the warning system is continuing."

NOISE-PROOFING A DIGITAL VOLTMETER WITH OFF-THE-SHELF MICROELECTRONICS

Electronics, Nov. 16, 1964, carries a 5-page article under the above heading by Stephen K. Ammann, Fairchild Semiconductor Div. Fairchild Camera & Instrument Corp., Mountainview, Calif. The subtitle and first five paragraphs are as follows:

"Meter uses dual-slope integration; simple design makes price competitive with conventional instruments.

"Conventional digital instruments that measure voltage have one major drawback: They can be fooled by noise.

"To sidestep the noise problem, engineers use complex and relatively expensive circuits. But even these instruments can be misled under certain circumstances.

"However, an integrating scheme has been developed for a virtually fool-proof digital meter that uses fewer components and many off-the-shelf microelectronic circuits. And the price of the instrument, about $2,000, makes it competitive with meters that don't use integrating techniques.

"The new meter is basically a four-digit instrument. It is accurate to within 0.01% of the reading ± 1 count.

"The technique was uncovered almost by accident. During the course of a study of possible uses of the company's line of operational amplifiers, the instrument circuit was hypothesized. The basic idea was to integrate an input voltage for a preset time, then change the input of the integrator to an opposite polarity reference voltage and measure the time--with an oscillator and counter--required for the integrated output to return to zero. A breadboard of the circuit performed to 0101% accuracy and needed fewer components than other schemes."

LASER INTERFERENCE PATTERNS

Electronics, Nov. 16, 1964, under the above heading carries a short resume of a paper presented at the National Electronics Conference, Oct. 19-21, Chicago by C. L. Rudder and D. A. Hayler, Missile & Space Div., Douglas Aircraft Co. The subtitle and paper are presented as follows:

"Interference fringes in Laser systems.

"Interference phenomena can be significantly more important with lasers than with other light sources because of the lasers' coherence characteristics. Interference fringes may have variou effects on the operation of systems involving lasers, such as com munications systems. The nature of such interference effects is studied here, and a theoretical model is established for double-ra interference; the conclusions are compared with experimental wo

"Detailed descriptions are given of the fringe patterns established when c-w gas laser light hits various flat and curved optic surfaces, such as lenses and mirrors and their combinations.

"As for practical laser systems, the effects of interference fringes are concluded to be especially the changes of intensity distribution within the laser beam and scattering of light. Intensity distribution changes, which are liable to adversely affect ve long laser communication links, can be minimized with antirefle tion coatings on the optical surfaces.

"The authors also warn against spurious results that may be obtained in some precise small-scale laser-beam measurements if the possible effects of interference fringes are not taken into account."

REDUCING RFI TO ELECTRONIC CABINETS

Electronic Packaging & Production, 222 West Adams St., Chica 6, Illinois, has a special series of articles and a Facilities Director on the above subject in the Jan. 1965 issue. An editorial entitled "R Shielding Techniques for Electronic Enclosures" contains Ten Rules Thumb for RFI Prevention. Three shielding manufacturers, Pneuma Corp., 2516 Wilkinson Blvd., Charlotte, N. C., Electronic Enclosur Inc., 3629 Holdredge, Los Angeles, Calif., Electro Rack, 1341 Cla dina Ave., Anaheim, Calif., have described their techniques in build ing shielded electronic enclosures for military and commercial appli cations.

Two articles "Shielding at Microwave Frequencies" by Martin R. Reynolds, General Instrument Corp., Hicksville, N. Y., and "A Pra tical See-Through Panel for RF-Tight Enclosures" by O. P. Schreibe Technical Wire Proeucts, Inc., Cranford, N. J., describe some of t more technical aspects. There are approximately seven pages of lis of manufacturers of cabinets and enclosures for electronic applicatic including RFI considerations.

THE AMPLITUTE DISTRIBUTION AND FALSE-ALARM RATE OF FILTERED NOISE

Under the above title, Bernard O. Steenson and R. C. Stirling, Advanced Armaments, Hughes Aircraft Co., Culver City, Calif., have written a 14-page article in the Proceedings of the IEEE, Jan. 1965 issue, the first two paragraphs of the Introduction being:

"The fundamental problem of detection of signals in noise arises in many electronics applications. Important examples are radar, communications, and telemetry. A typical method of signal detection involves setting a voltage threshold above most of the noise but not the signal plus noise. The signal is detected when the total process exceeds the threshold, the event is termed a 'false alarm.' The magnitude of the threshold voltage thus affects both signal detection and false-alarm rate. The ability of an electronic system using a threshold stage to detect a signal in noise is, therefore, closely related to false-alarm rate.

"When the signal spectrum is narrow band, a matched bandpass filter followed by a detector and threshold stage is often an effective means of signal detection. Frequently, however, reasons of economy, reliability, or problems in tuning to the signal frequency dictate a wider predetection-filter bandwidth. In this case, postdetection filtering is a practical expedient for improvement of signal-to-noise ratio. A single-section resistor-capacitor PDF is reliable, light, and inexpensive. Adding a second section modifies the frequency-attenuation characteristic to more nearly match power spectral density of typical signals. Optimum design of such a detection system requires the ability to predict false-alarm rate given predetection-filter bandwidth, product of predetection bandwidth times postdetection time constant (BT_O), and threshold voltage."

COMMENTS ON MSFC-SPEC-279 BY I&M GROUP NEWSLETTER

EMI-RFI STANDARDS?

The increasing use of micro-miniature circuitry and attendant sensitivity to surrounding fields has produced several new developments in the Electromagnetic Interference Radio Frequency Interference field.

Primary among these is the recent announcement of a new Standard Specification for EMI -RFI adopted by Marshall Space Flight Center, NASA, for application to Saturn Vehicles and Project Apollo.

The new standard (MSFC-SPEC-279) provides more stringent test requirements for system electromagnetic compatability and sub-system susceptibility and interference. James C. Toler of the MSFC Quality and Reliability Assurance Laboratory stated the EMI compatability tests will be the final phase of Saturn electrical-electronic checkout and said this is primarily because of "a lag in the state-of-the-art in equipment to generate these broadband signals and monitor the response."

This increased hardware need further emphasizes the critical requirement for the development of standards and precision measurement techniques in this field. At an NBS session on Radioelectronic Systems Performance and the State of the Measurement Art in May of this year, it was pointed out that the lack of a national standard for X-band power measurement resulted in a $3 million system redesign by one manufacturer. Other areas of standards needs are spectral-intensity of impulse generators, EMI Environmental measurements and allied fields.

Representatives of both government and industry are generally agreed that it is imperative for all concerned with this type measurement strive to establish interim standards by comparison techniques in an effort to achieve greater nationwide agreement.

NEW PRODUCTS

Low-Noise Amplifiers Detect Minute Signals

Electronic Design, Nov. 9, 1964, under the above heading carries an advertisement by the Honeywell Inc., Philadelphia Div., Phila., Pa.

Types I and II offer a dc-to-30-cps frequency span by using 400 cps choppers. Type III, styled for multiple relay-rack mounting, has four terminals and a frequency response to 2 cps, with 60-cps choppers. All types operate from 120-v lines.

How Beldfoil Reduces Hum-Noise

Electronic Design, Nov. 9, 1964, under the above heading carries an advertisement by the Belden Mfg. Co., P. O. Box 5070-A, Chicago 80, Illinois.

This company is making a new type of cable with total shielding. In the above mentioned issue of Electronic Design, page 60 answers questions to this cable.

Insulation, Jan. 1965, carried the following information on products of interest to EMC:

Copper Shielding Tape for Use in Cable Splices

As an all-metal shielding braid tape available in a handy "electrician's" size roll, "Scotch" No. 24 is of multistrand construction knitted from #36 awg tinned copper wire. The braid is designed for use in restoring electrostatic shielding on cables when building splices and stress relief cones. The product is claimed to apply easily and conform well to splice and termination contours. Dept. W4-693, 3M Co., 2501 Hudson Rd., St. Paul, Minn.

Silver Coated Copper Powder for Conductive Resins, Pressed Contacts

A new bimetallic powder, "Silco-powder," is a silver-coated copper material claimed to be suitable for use in applications in which solid silver or materials with high silver content are now being used. It can also be used to up-grade base metal powders by inhibiting oxide formation and increasing or maintaining electrical conductivity over long periods of time. The new material is expected to be useful in the electrical contact field as a substitute for fine silver powder where the Stokes press method of pressing contacts is employed. Similarly, another anticipated application is in the area of conductive epoxies where the product could substitute for silver powder or flake. Industrial Products Div., Handy & Harman, 850 Third Ave. New York 22, N. Y.

Silver-Filled Silicone Grease Can Serve as a Conductive Lubricant

A silver-filled, electrically conductive silicone grease, E-Kote 3028, reportedly combines good conductivity (volume resistivity is approximately 0.01 ohm-cm) with good lubrication. It is reported that the material retains its consistency over a temperature range from 65 to 200°C, and will not drip or run when applied to a vertical surface and heated to 200°C. The grease is stated to be ideally suited for use as a conductive lubricant for switch blades and slip rings. It is also suggested for making non-permanent electrical connections, and as a "fluid gasket" to improve electrical and thermal conductivity between mechanically fastened parts. Epoxy Products Inc., Waldman, 133 Coit St., Irington 11, N. J.

New Transient Detector Available

Huggins Labs., Inc., 999 East Arques Ave., Sunnyvale, Calif., has developed a latest model of a transient detector series called "Differential Transient Detector, Model 2401". This model is useful for applications involving transients between points which are both high from ground or where particular care must be exercised to prevent ground loops via the instrumentation. This model provides 0.1 microsecond response and is available in any number of channels and with a wide variety of characteristics to meet specific requirements.

Time-Saving Calculators Available

Rapid Electric Service, 1348 Grandview Ave., Glendale 1, Calif. has three new time-savers as follows:

Rapid Conduit Sizer - for instantly obtaining direct reading method for combinations of two or more different wire gauges in same conduit - $4.50.

Rapid Voltage Drop Calculator - $4.50.

Rapid Knock-Out Spotter - for immediate measurement to centers of new conduit entrances - $1.50.

Stoddart Brings Out Attenuator Set

Stoddart Electro Systems, 2045 West Rosecrans Ave. Gardena, 49 Calif. has brought out a Standard Attenuator Set Model SA-1 consisting of eight accurately calibrated coaxial attenuators to provide 50-ohm standard references at 3, 5, 10 and 20 db over the frequency range from DC to 10 GC. The SA-1 Attenuator Set is suitable for use as laborator standards or other precision measurements with calibration accuracy traceable to the National Bureau of Standards.

Stoddart also announces the opening of an Eastern United States repair and calibration service at 6218 Georgia Ave., N. W., Wash. 24, D. C. In addition, fully operational RFI sets will be available at the center to lend users while their equipment is being repaired.

Components for Testing to MIL-STD 826

RF Interonics, Inc., 15 Neil Court. Oceanside, 72, N. Y. announces the availability of components required in order to conduct radio frequency interference measurements in accordance with the new specification MIL-STD 826 (USAF) entitled "Electromagnetic Interference Test Requirements and Test Methods."

Part No. RC226 conforms to the specification requirements for a 10MFD feedthru capacitor to be installed in power lines during conducted and radiated measurements. The part is rated for a maximum of 200 amperes 275 VAC and is designed to be bench mounted. Part No. RC226A is similar electrically, but designed to be mounted thru the wall of a shielded enclosure. Capacitors with higher current and voltage ratings are available, if required.

RF Intersonics also manufactures the low pass filters required by Method 3001 of MIL-STD 826 for conducted interference measurements from 30 cps to 14kc.

Filter type RF1646-5 is rated at a maximum of 5 amperes 275 VAC 0-400 cps, with a cut-off frequency of 20 kc. Type RF1646-20 is similar, except that the maximum current rating is 20 amperes.

New Oscilloscope Probe

WMA Andersen Co., Inc., Pleasant Valley, Connecticut, announces an oscilloscope probe primarily designed to facilitate examining low level signals. It is a completely transistorized device with a gain of 26 db at the input of the oscilloscope and a frequency response of 300 cycles to 70 megacycles. A separate power supply is furnished which can be placed behind the scope. The probe amplifier has a fail-safe circuit which protects it against accidental reversal of power supply polarity which could happen if a repair were improperly made. The price of the Amplifier and Power Supply is $175. 00.

EDITORIAL COMMENT

There has been a sudden educational and editorial up-surge of interest and activity in the RFI/EMC field. Your editor has had six separate requests for some sort of glossary of terms which would permit common definitions. With the University of Penna. and the Mass. Institute of Technology starting summer courses, and the Chicago Chapter just having completed one, it should be embarrassing to all of us if we have not decided on what we are going to teach. Maybe we cannot agree to be technically perfect with every term but, at least, we can make available to all who inquire, the various ideas regarding those terms under dispute. Your editor would like to know of any other activities, which are planned, which would need such a glossary. Maybe we can stave off more confusion.

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