

# Professional Technical Group on ELECTROMAGNETIC COMPATIBILITY



Number 29

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## A MESSAGE FROM YOUR NEW CHAIRMAN WHERE DO WE GO FROM HERE?

As your new PTGEMC Chairman, I should like all of us to do a little introspection regarding our needs and action we may take. I feel this is necessary since we are so preoccupied that little time remains for pondering fundamentals. I shall touch upon a few situations to start your thinking.

The EMC Community needs a good quantitiveness boost. For example: What does compatibility really mean? What are EMC performance criteria? What is the difference between susceptibility and vulnerability? What does a valid RFI prediction model mean? What does an equipotential plane really mean? What does optimize mean? What justification exists for the interference specification limits?

Regarding effectiveness criteria for EMC, there exists virtually none despite efforts to predict or measure performance and to reduce spectrum contamination. For example, how is computer simulation used to determine effectiveness of a Battle Group or an Air Defense Sector? Where is the modeling of the human element? Minimizing RFI aborted messages is meaningless unless redundancy, logistics, security, and cost impact is considered.

Regarding environmental simulators, if performance criteria are established for equipment to be connected to the simulator, one can translate criteria mean and variance into parameters to be measured, the generation functions required, and allowable variations. Simulator characteristics are then established together with cost.

On the subject of instrumentation used by the EMC Community, it is not significantly different from that used ten years ago, notwithstanding added creature comforts and extended frequency range. Sensitivities are inadequate and bandwidth choice is limited. The prime method of documenting hard copy data is still the meter-reading method. EMC instruments are not designed for statistical recording of data despite the need.

Another offender involves the methods of using existing instruments, such as in site surveys where suitability for locating radars or communications equipment is to be determined. The statistical nature of the number of radiators on-the-air at any one time, scintillations due to antenna scanning effects, and the like require defining meaningful criteria and standards.

Regarding education and training, untapped opportunities exist. For example, while we conduct our own EMC symposia, we are not crosspollinating outside the EMC Community. The presentation of EMC papers at non-EMC symposia would stress the tutorial flavor since education and injection of EMC impact into other disciplines are sought.

Finally, improvement is required in the area of components and materials. One example includes developing tubes and transistors which have greater linearity for minimizing intermodulation. Another example involves developing electronically tunable inductors and capacitors having high Q-factors so that TRF receivers may be exploited in order to relieve the susceptible superheterodyne receiver.

Your reactions to the above are invited. The next issue of the PTGEMC Transactions will have more to say on this.

Donald R. J. White  
PTGEMC Chairman

## PTGEMC 1963-1964 Committee Chairmen:

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## CHAPTER MEETINGS

### Chicago Chapter

A meeting was held on April 9th, 1963. A paper was given by R. B. Schultz, Boeing Aircraft Company, Seattle, Washington, entitled - "Various Aspects on Shielding."

### Los Angeles Chapter

A meeting was held on March 21st, 1963 and the subject was "Electromagnetic Compatibility". Those taking part in the program were William Boldeau, David Neishanv and Charles Thornton, of the Douglas Aircraft Company, Santa Monica, California.

### Philadelphia Chapter

A meeting was held on April 16th, 1963. Dr. E. F. Buckley, of Emerson & Cuming, Inc., Canton, Massachusetts gave a paper on "Techniques of RFI Shielding and Gasketing."

### Washington D. C. Chapter

A meeting was held on June 18th, 1963 at which Herman Garlan, of FCC, Washington, D. C., gave a talk on "1962-63 Activities of the PTGEMC Administrative Committee and Relations with IEEE".

## SAE To Hold Technical Session on RFI/EMC in Los Angeles:

The SAE is scheduling an all day Technical Session on RFI/EMC on Friday, September 27th, 1963, at the Ambassador Hotel, Los Angeles, California, starting at 9:00 A. M. in the East Venetian Room.

The program is as follows:

## ELECTROMAGNETIC COMPATIBILITY And RADIO INTERFERENCE

Chairman and Organizer: C. M. Dean, Pratt & Whitney  
Aircraft Division, United Aircraft  
Corporation

### Part I - 9:00 A. M.

#### Management Responsibility for Electromagnetic Compatibility

F. J. Nichols, Pres., Genistron, Inc.

#### Initiating an Electromagnetic Interference Control Plan

William Lash, EMC Group Engr., Saturn Engrg.,  
Douglas Aircraft Company

#### Electromagnetic Control of Large Weapons Systems

W. J. Baldeau, Technical Staff, Systems Research &  
Planning Div., Aerospace Corporation

### Part II-2:00 P. M.

#### Incite for Interference Control

J. H. Robinson, III, Space and Information Division,  
Apollo Engrg., North American Aviation, Inc.

#### Interindustry Committee Approach to Compatibility

C. B. Pearlston, Jr., Supv., EMC Group, Nortronics  
Division, Northrop Corporation

#### Instrumentation Requirements for Systems Compatibility Analysis

J. E. Berger, Mgr., Stoddart Aircraft Radio Company

(Planned by SAE Technical Committee AE-4 Radio Interference  
with the cooperation of Los Angeles Section Institute of  
Electrical and Electronics Engineers Professional Technical  
Group on Electromagnetic Compatibility).

### New Technical Paper on Shielded Room RFI Filters:

Genistron, Inc., 6320 West Arizona Circle, Los Angeles 45,  
California, has brought out a new technical paper entitled "Shielded  
Room Power Line RFI Filters and Power Factor Correction, Design  
and Application Criteria". This is an attempt by the Genistron  
Engineering Department to explain in simple terms on a semi-  
technical basis what is required for filter design, power factor  
correction, and application information that is necessary to have a  
satisfactory shielded room from a standpoint of shielding in the  
structure itself, and filtering on all power and/or other lines entering  
into the shielded enclosure. Members of PTGEMC may request  
copies of this technical paper on their company letterhead.

### IEEE Spectrum Magazine to Bow January 1964:

A new monthly magazine titled "IEEE Spectrum" will be pub-  
lished by the Institute of Electrical and Electronics Engineers start-  
ing January, 1964.

Its aim is to present technical articles "of high professional  
quality written so as to be meaningful to a wide audience", IEEE  
officials explained.

The magazine will cover the entire spectrum of electrical and  
electronics engineering and will be distributed to all IEEE members,  
except student members. It will include review, tutorial, and  
application papers; occasional theoretical papers; and news of the  
profession and the Institute.

### ELECTRONICS Publishes Material on RFI/EMC:

In the June 14th, 1963 issue of Electronics, a page discussion of

RFI/EMC appeared under the heading "What Price RFI  
Control?". The first two paragraphs were: "Radio-  
frequency interference (rfi) casts a surprisingly large  
shadow. Some people say it costs the electronics industry  
as much as five percent of the industry's annual sales.  
The amount of time spent in engineering around rfi is  
incalculable."

In the June 21, 1963 issue of Electronics, a special 24-  
page report, by Sy Vogel, Associate Editor, appears under  
the heading "RFI Causes, Effects, Cures." It is divided  
roughly into four sections: Introduction; RFI Measurements  
and Instrumentation, Intersystems and Systems Control of  
RFI and Suppressing RFI.

Reprints may be obtained from Electronics Reprint Dept.,  
330 West 42nd Street, New York 26, New York. Key number  
R-39, at 1-10 copies 75¢ each; 11-24 copies, 60¢ each and 25  
or more copies 50¢ each.

### Low-Level DC Microvolt Measurements:

Ralph Morrison, Dynamics Instrumentation Company, has  
written a page article, with three schematics, in the July 1963  
issue of Instruments and Control Systems, on ways to reduce  
interference in making microvolt measurements. The text of  
the article is as follows:

"Low-level DC instrumentation suffers from two main  
handicaps to accuracy - spurious signals carried by (1)  
power line leakage and circulation currents, and (2) a  
60-cps synchronous modulation at the voltmeter input.

"To illustrate the problem of power line effects, con-  
sider a typical power-line loop (Fig. 2) with a circulation  
path for power currents flowing through the capacitance  
that exists between the power-transformer primary and its  
shield. A 'pump voltage' of approximately one-half the  
power-line voltage (60 volts if a 120-volt source) causes the  
current  $i$  to flow in the input R. This current does not gen-  
erally cause a problem unless it flows in circuit impedances  
that are being measured, or if the instrument has poor  
common-mode rejection. For example, if the voltmeter is  
measuring a base-emitter potential difference, the current  
 $i$  would flow in the base resistor to ground, and thus modify  
the effective operating point of the transistor.

"The solution to this problem is to double-shield the pow-  
er transformer, as shown in Fig. 3.

"The second shield eliminates the pump voltage, reducing  
the current to that due to the difference of potential between  
 $E_2$  and  $E_1$  (ground-loop emf); reactive currents still flow,  
but only within the transformer itself.

#### Synchronous Modulation

"Operation of the instrument modulator at the same fre-  
quency as the AC line power supply poses a further problem-  
line frequency pickup can not be differentiated from the modu-  
lated DC input. This means that stable repetitive errors can  
exist in low-level measurements made in systems where  
reactive power currents can flow. This problem is solved  
by using a modulation frequency such as 370 cycles per  
second, which is nonsynchronous with the 60-cps line and  
its harmonics, and also with 400 cps, another common  
power frequency.

"The resulting transformer and nonsynchronous drive  
circuitry can be used as a second shield (Fig. 4).

"The instrument shown in Fig. 1 uses a 370-cps chopper  
frequency to achieve freedom from noise, resulting in a  
sensitivity up to 100 microvolts full scale. Specifications  
include:  $\pm 1\%$  accuracy; 100-megohm minimum input im-  
pedance; storage battery for isolation from power line;  
'floating' characteristic for measuring differences in dc  
potentials at various levels; 7.2" mirror scale; no vacuum  
tubes; complete isolation due to battery operation at low  
voltage levels if required."

### FCC Redefines Ultrasonic Equipment Limits:

Effective August 26th, 1963, the FCC has amended Part  
18 of the FCC Rules to redefine ultrasonic equipment and

eliminate the frequency limit of 20kc/s. The amendment now reads as follows:

## " 18.2 Definitions.

\* \* \* \* \*

"(e) Ultrasonic equipment shall include any apparatus which generates radio frequency energy and utilizes that energy to excite or drive an electro-mechanical transducer for the production of sonic or ultrasonic mechanical energy for industrial, scientific, medical or other noncommunication purposes."

### RFI Filters and Their Application:

Electrical Design News, May 1963, carries a three-page article, under the above title. Descriptive paragraph are as follows:

"Increasing emphasis by military and civilian agencies of the government has been placed upon proper radio-frequency-interference control. This and the susceptibility requirements of present-day receivers and other signal-detection devices has required the circuit-design engineer to familiarize himself with various types of RF-suppression components. He also must be familiar with the optimum methods of installation required to fully realize the performance characteristics of these components.

"RFI filters required for use in power lines, control and signal leads, audio communication circuits and similar suppression applications may range from the simple bypass-type capacitor to the more complex, multistage ladder-type filter network."

### Total Shields Solve System Problems:

Under the above title, Electrical Design News, May 1963, carries a page article, the first three paragraphs of which are:

"Modern high-gain sensitive electronic equipment has placed stringent requirements on the allowable hum and noise derived from pickup and interaction between conductors in the cabling and wiring. Standard braided and spiral shields have been found to be inadequate in reducing the pickup and transmitted noise to the ultralow levels currently required. Current trends toward miniature equipment suitable for aircraft and space applications place added requirements for lightweight, small-diameter, flexible cables with the ability to stand up under extreme environmental conditions. A practical solution that satisfies these stringent requirements was obtained by combining the electrical characteristics of aluminum and the excellent insulating properties of 'Mylar'.

"The aluminum is bonded to the 'Mylar' with a colored adhesive that is used for identification purposes. The combined thickness varies from 0.0007 inch to 0.004 inch.

"This aluminum-'Mylar' tape known as 'Beldfoil', combined with unique wrapping procedures, provides the desired 100-percent effective shield. A feature of every 'Beldfoil' shield is a drain wire that is in contact with the aluminum portion of the shield along the entire cable length and thus drains any accumulated static charges from the shield. In addition, the drain wire is a convenient ground wire with sufficient circular-mil-area that it may be used as a conductor for relay and annunciator circuits."

### "Radio Interference from Carbon-Brush Operation:

Under the above title is a 5-page article in Electro-Technology, July 1963, by R. E. Nelson and J. E. Diehl, Stackpole Carbon Company, St. Marys, Pennsylvania. The first two paragraphs and another pertinent section are as follows:

"Direct-current motors and generators produce

consistently high levels of radio interference. Since the machine designer is normally primarily responsible for the reduction of interference, it is essential that he have the best possible working knowledge of proper practices for interference reduction.

"Some of the theoretical aspects of the primary sources of interference from both slip-ring and commutator machines will be outlined here. These considerations, together with the summarized results of many laboratory investigations, are intended to serve as direction indicators for both the machine designer and user. Although the relation of many of the properties of carbon-brush materials to radio interference is still not known, it is believed that the major significant aspects have been thoroughly investigated.

### "Other Sources of Interference

"It has been stated that interference from commutation and from sliding contacts are the two major types found at the brush contact in d-c motors and generators. It may be generally helpful to list some of the other types of interference also present, which are closely associated with the process of current transfer through the brush-commutator circuit. These are classified as follows:

"1. Interference from thermoelectric voltage generation increases with increased current density in the contact areas. As the current density is increased, more heat is generated in the contact resistance and the temperature of the brush surface and the commutator surface increases. This heat is generated in the small actual conducting surfaces which carry the current from the brush to the commutator. The magnitude of this interference is increased as the current density increases.

"2. Thermal agitation is provided by current flow through a brush material and varies with brush temperature. Usually this effect is so small it is considered negligible.

"3. Material transfer takes place when the arc, carrying current between the brush and the commutator, develops a temperature sufficient to melt microscopic metallic areas of the commutator. The metallic material may or may not be deposited on the brush face. The presence of this material, either on the face of the brush or in the space between the brush and the commutator, causes still greater irregularities in the contact areas and is conducive to an increase in interference. Loosened bits of brush material can also cause irregular contact areas."

### Shielded Underground Cable Detection by Electromagnetic Radiation:

This paper by J. Zawels and J. Harley appeared under the above title in the July, 1963, issue of Electrical Engineering of the IEEE. A summary of the article is as follows:

"Underground cable can be located by the electromagnetic radiation above ground from a signal injected into the cable. There exists an optimum frequency band for each cable type, despite the fact that the metal shield surrounding the cable suggests the use of as low a frequency as possible. Equipment consisting of a simple 50-kc mains-operated signal generator and a portable transistorized detector unit that can locate cable through ten feet of soil is described. With suitable precautions, it is not necessary to isolate the cable from the power supply when using the equipment."

### Varactor Slide Rule:

Microwaves, July 1963, contains a twelve page insert which can be made into a varactor slide rule for quick correlation of diode specifications. This special insert also contains instructions for its assembly and use.

### Spectrum Signature Measurements:

Under the above title, H. M. Sachs, ECAC, Annapolis, Md., has written an article in the May 24th, 1963 issue of Electronic Design. The sub-title and first two paragraphs state:

"Measurement techniques for spectrum signatures were discussed in the March 15th issue. With proper precautions, these standards (MIL-STD-449A) can be extended to obtain RFI data on radar systems not covered in the original plan."

"With minor modifications, present spectrum-signature collection plans can be used to obtain considerable information on a variety of equipment types. Although the collection plan (MIL-STD-449A) is extended for particular types of equipment,

the table shows where it can be applied to radar systems.

"In the radar field, the plan is generally suitable for obtaining transmitter and antenna data on most equipment. However to obtain reliable data it is necessary to examine some of the misinterpretations and measurement problems encountered."

#### Excessive Noise in Component Parts:

Alan P. Stansbury, Chief Engineer, Quan-Tech Laboratories, Inc., states that his talk before the Los Angeles Chapter on Component Parts under the title "Excess Noise in Component Parts" is not available. However, to those who are interested in this subject, Quan-Tech Laboratories, Inc., P. O. Box 187, Boonton, N.J., has two 4-page papers which contain much of the same material and which will be sent to interested members of PTGEMC on request. They are: "Electrical Noise & Component Reliability- A Brief Summary of the Origin, Nature and Implications of Noise in Electronic Components" and "Noise Analysis and Potential Failure Mechanisms in Semiconductor Diodes".

#### Radio Through Rock:

Electronic Industries, July 1963, page 8, has the following news item:

"Radio through rock is being pushed hard by DOD. Scientists at Air Force Cambridge Labs and in industry are stepping up efforts to perfect an underground radio system to link below-ground-level command posts with missile sites. Military planners admit that such posts are useless unless they can receive orders without jamming. Plans include a system of antennas buried a mile or more down to transmit RF signals through rock strata of the earth's crust. One scientist remarked that given suitable insulating rock, highly resistant and moisture-free, communications could be maintained half-way around the world. Signals would be much harder to jam and almost impossible to intercept. They would be immune to bombs."

#### RFI Control Hampered by Sketchy Data:

Electronic Design, July 19th, 1963, in a special report titled "Designing for the Military", has two pages under the above title. The text, reprinted with permission accompanying two charts showing the chain of requirements, is as follows:

"Electromagnetic compatibility (EMC) is so much everybody's problem that it is often no one's problem."

"As result, while the electromagnetic environment deteriorates under the widening use of complex and high-powered equipment, designers are forced to cope with conflicting MIL-SPEC requirements, a lack of suitable test instruments and some procurement auditors who still think money allotted for RFI studies is padding to be disallowed."

"Hopefully, improvement is coming. The military, spurred by the growing difficulty of achieving electromagnetic compatibility, has started an across-the-board interference-control program. Through its agencies, DOD is expanding its list of standards and specifications in EMC, it is developing test equipment and simulation techniques and hardware, and is compiling data on the electromagnetic environment."

#### Basic Problem: Not Enough Known

"Most of the effort lies in trying to solve one basic problem: Engineers in industry and Government do not know enough about what generates interference and what equipment is susceptible to which kinds of interference."

"To prepare for the results of DOD's compatibility effort, industry has been asked by J. M. Bridges of the Office of the Director of Defense Research and Engineering to centralize the responsibility for EMC within each company at a management level, and to introduce training for design engineers in electromagnetic compatibility."

"In the near future, Bridges warns, development and production contracts will specify numerical levels of system compatibility in the operational environment as well as within the particular system."

"Performance in the environment is the new element in RFI engineering and is basic to the over-all interference control program

now in operation. However, military EMC specialists realize that enough environment data, automated test equipment and RFI services have to be provided before such demands can be realistic. Such facilities as the Electromagnetic Compatibility Analysis Center, at Annapolis, Md., and the Electromagnetic Environmental Test Facility, at Ft. Huachuca, Ariz., are nearing full operation and will soon be providing answers to major problems in the difficult area of environment characteristics."

"Recently, the international special committee on RFI issued two specifications on field strength, modified versions of which have been approved and published by the American Standards Association as C63.2 and C63.4. These standards extend the frequency range covered by older specifications."

"The Navy's Bureau of Ships is publishing a series of five RFI guides for designers applicable to radar, receivers, transmitters, switching circuits and terminal equipment. These will be available from the Government Printing Office in a few months."

#### "FREQUENCY" Discusses Conference Reports:

The new technical publication, Frequency, 167 Corey Road, Brookline 46, Mass., is starting a policy of reprinting summaries of pertinent papers which have been presented at various conferences and which have a bearing on frequency. It had the following to say about the PTGMIL Los Angeles Conference, in the May-June 1963 issue:

#### "Frequency Engineering in Communications"

"Electromagnetic compatibility and radio frequency interference frequently appear in the titles of conference papers but, as a rule, audiences receive only a superficial treatment of the subject. Furthermore, the presentations are usually overly philosophical in nature and the design engineer's comment at the end of the paper usually runs something like this: 'What he said makes sense.... Now what do I do? How do I incorporate his facts in my work?' J. W. Steiner and R. F. Bloom of the ITT Federal Labs., Nutley, New Jersey, broke this pattern in a paper entitled 'The Frequency Engineering of Modern Communication Systems.' The change was refreshing since the listener was treated to a detailed expose of a typical frequency engineering problem similar to that encountered in the US Air Forces' European-Mediterranean tropospheric scatter communication system, Big Rally II communication system and other major communication systems involving both tropospheric scatter and microwave line-of-sight transmissions."

"Frequency engineering, as defined by Steiner and Bloom, consists of a process of selecting specific frequencies within a desired frequency band which permit the addition of a communication system to an existing electronic environment. Interference-free operation is the prime criterion for judgement of a resultant frequency plan. Secondary criteria include spectrum conservation and future growth potential. To illustrate the method of approach, the authors postulated a frequency division multiplex radio-telephone communication system and treated, sequentially, five system considerations."

"1. Interference Threshold Levels. Communications receivers exhibit two interference threshold levels: the point at which the receiver detector becomes sensitive to interfering signals, and the level at which the receiver mixer becomes saturated by the interfering signal. -103 dbm was given as a value for the former based upon a known relationship and -30 dbm for the latter."

- "2. Transmit-Receive Separation Criteria
- "3. Frequency-Space Separation
- "4. Frequency Channelization Plan
- "5. Frequency Selection

"..... However, the authors emphasized that problems associated with automated frequency engineering should not be assumed insurmountable and referred to the work of the recently established Electromagnetic Compatibility Analysis Center in stating that the next few years should see considerable progress in this direction."

#### Navy Report on Conductive Glass:

The U. S. Naval Civil Engineering Laboratory, Port Hueneme, California, has brought out a Technical Report R 242 under the title of "Low-Frequency Shielding Effectiveness of Conductive Glass". The Abstract states:

"The shielding effectiveness of conductive glass at low and intermediate frequencies (100 kc to 1,000 mc) was investigated. A mathematical model was used to describe the absorption and reflection. This model is based on a film applied to the glass substrate which represents a barrier with finite thickness and relative conductivity. Experimental data agreed well with theoretical calculations. Coated glass exhibits a permeability similar to that of free space, so that low-impedance attenuation is limited to the conductivity of the film. The analysis is primarily concerned with high-impedance, near-field incident waves. Transmission in the visible spectrum was also determined for several 4- by 4-inch conductive glass samples which vary in surface resistance from 9 to 125 ohms/square. Larger samples (8 by 3 feet) of conductive glass were also investigated."

Copies may be obtained from DDC/ASTIA.

#### Interference to Aircraft Electronic Equipment:

Under the title "Interference to Aircraft Electronic Equipment From Devices Carried Aboard", the Radio Technical Commission for Aeronautics, Washington 25, D. C., has prepared a Paper on the above subject identified as Paper 39-63/DO-119. The Introduction states:

"The studies reported herein were undertaken following the receipt of information that a number of cases of interference to aircraft electronic equipment from passenger-operated electronic devices had been experienced. One of the more serious of these instances involved an air carrier aircraft. A portable FM broadcast receiver operated by a passenger caused the aircraft's navigation system to indicate that the aircraft was off course by more than 10°. Actually, the aircraft was on course. When the portable receiver was turned off, the malfunction of the navigation system ceased. On the basis of this and other instances posing a serious potential hazard to the safety of aeronautical operations, RTCA established its Special Committee 88 (SC-88) with the following Terms of Reference:

"SC-88 is directed to determine those performance characteristics of portable electronic devices, carried aboard aircraft for personal use, which are significant from the standpoint of creating interference to aircraft electronic systems and to make appropriate recommendations for the elimination of such interference."

The Paper contains, as an Attachment, the Final Report of the FAA titled, "Measurement of Interference to Airborne Navigation and Communications Equipment", and the FCC tests of electronic hearing aids. Copies may be obtained by sending \$1.50 to: RTCA Secretariat, Room 1072, Building T-5, 16th & Constitution Avenue, N. W., Washington 25, D.C.

#### Air Force Brings Out Electromagnetic Compatibility Lecture Series:

The Directorate of Operational Support Engineering, Aeronautical Systems Division, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, is making available to qualified DOD contractors its Lecture Series, given August and September 1961, in three volumes, on Electromagnetic Compatibility. The Series was presented by Armour Research Foundation of the Illinois Institute of Technology and individual lectures were given by invited authorities in various fields. A table of contents is as follows:

##### **VOLUME I**

- Lecture 1 Welcome and Introduction
- Lecture 2 Technical Summary of Course

##### **Lecture 3 Electromagnetic Compatibility Control-System Approach**

##### **VOLUME II**

- Lecture 4 Interference Reduction Components
- Lecture 5 Interference Reduction Techniques
- Lecture 6 Interference Antennas and Propagation
- Lecture 7 Interference Instrumentation and Interference Specification
- Lecture 8 Interference Specification and Measurement Techniques
- Lecture 9 Interference in Communications Systems
- Lecture 10 Natural Interference and Lighting Protection (Deleted)
- Lecture 11 Interference in Radar Systems
- Lecture 12 Interference Prediction and Analysis
- Lecture 13 Future Interference Problem Areas

##### **VOLUME III**

- Lecture 14 Terms and Definitions (Deleted)
- Lecture 15 Radio Frequency Shielded Enclosures
- Lecture 16 MIL Specification Testing Demonstration
- Lecture 17 Practical Application of Filters and Suppression Techniques
- Lecture 18 Near and Far Field Radiation
- Lecture 19 Shielded Enclosure Effectiveness and RFI Field Measurements
- Lecture 20 Radiation Hazards
- Lecture 21 Cable Coupling Interference Problems
- Lecture 22 Transient Effects
- Lecture 23 Weapon System Compatibility

The Lecture Series is now available through the Defense Documentation Center (ASTIA), Arlington Hall Station, Arlington 12, Virginia, for official use to organizations with authorized DDC services, under the following numbers: Volume I - AD 290 330; Volume II - AD 290 331, Volume III - AD 290 332. They will not be authorized for the public domain by availability through the Office of Technical Services of the Department of Commerce.

#### An Analysis of the Factors Which Determine Signal/Noise Discrimination in Pulsed-Carrier Systems

Under the above title is an article by Dwight O. North, David Sarnoff Research Center, RCA Laboratories, Princeton, N. J., in the July, 1963, issue of the PROCEEDINGS of the IEEE. The first paragraph of an introduction to this article by Lamont Blake, U. S. Naval Research Laboratory, Washington, D. C., is as follows:

"This classic report, written in 1943 by Dwight O. North, appears here for the first time in a publication readily available to the engineering profession, although it was issued as an military-security-classified report during World War II (RCA Laboratories Report PTR-6C, dated June 25th, 1943). It is reprinted here because of its historical importance and because it is still a basic but otherwise unavailable reference of great value in current research."

The summary of the article is as follows:

"Summary - The smallest signal discernible through background noise is formulated in terms of the pulse energy, its repetition rate, the receiver design, and the choice of integrating and indicating means.

"The smallest signal visible on a Type-A scan can be improved upon by the use of electromechanical integrators. Integration before detection is, in theory, ultimately the most effective, but runs into serious practical difficulties. These are avoided when the integration is performed after detection. Optimum predetector selectivity is formulated. The optimum detector (square law) is found, and other detectors compared. A transmitter criterion provides a basis for comparing the effectiveness of transmitters, and shows how, at the expense of range resolution, longer pulses can increase visibility."

### Capacitor Reduces Noise in Differential Amplifiers

Electronic Design, April 26th, 1963, in the Ideas for Design Section, has an idea by Maxwell Strange, Goddard Space Flight Center, Greenbelt, Maryland, as follows: (schematic omitted)

"With the introduction of dual transistors, differential stages have become more interesting as input circuits of dc amplifiers. Although this arrangement can be very effective in cancelling power-supply noise and drift created by temperature changes, it cannot attenuate random input-stage transistor noise or noise present on the input signal.

"If the output is to be read on a digital meter or coded for telemetry, excessive noise will cause instability of the least significant digits. Since these dc amplifiers usually employ a large amount of negative feedback, reactive components must be used with caution to preserve good stability. For instance, a filter on the output would probably require a stable unity-gain isolating amplifier.

"The simplest and safest method we have found for effectively attenuating noise frequencies is to connect a capacitor between first-stage collectors, as shown. At higher frequencies this capacitor becomes a low impedance and the ac components, regardless of origin, appear at both collectors. These are rejected by the second differential stage as a common-mode signal. This connection represents a minimum sacrifice in reliability since no phase-shift is introduced; the single component has a minimum capacitance value, since it is connected between high impedance points; and large variations in leakage will not affect circuit balance."

### Diathermy Creates Fire Hazard:

The Fire Protection Review, February 1963, London, England carried the following item: (extracts)

"A new fire hazard was discovered as the result of a recent fire in a spring mattress, with no visible signs of burning, in a private house where a patient was being treated for sciatica by means of ultra short-wave therapy apparatus. Reporting on this, the Chief Officer of Surry Fire Brigade, Mr. A. H. Johnstone, comments that in view of the frequent use of this type of apparatus by hundreds of physiotherapists throughout the country, he feels that the danger of fires being caused in this way should be more widely known." (Operating at 27.12 mc.)

"In experiments carried out, it was found that sparking could easily be produced between the coils of two springs in close proximity to each other, but otherwise insulated, and that cotton-wool could easily be ignited by the spark. The weight of the person on the bed would tend to compress the springs and so increase the possibility of this occurring."

### Better Superhets for Sideband Reception:

In the May 10th, 1963 issue of Electronics, under the above title, W. Bruene and E. Schoenike, of the Collins Radio Co., and E. Pappenfus, of Granger Associates, have authored an article on the above subject. The paragraphs devoted to Noise Reduction are as follows:

"Although there is no general method of reducing the effect of random noise in communication systems other than by using higher transmitting power, more sensitive receivers and complex modulation schemes, much interference is caused by impulse noise, such as that produced by automobile-ignition systems and switch-clicks. This type of noise must have high amplitude to contain enough average energy to cause interference. It is therefore possible to discriminate between noise and signal on the basis of amplitude. The greater the amplitude, and the shorter the pulse, the easier it is to reduce or eliminate it without affecting the signal.

"Successful ssb reception requires a fast agc attack and slow decay. From the standpoint of impulse noise interference, this may be unfortunate, because the agc becomes quite susceptible to loading up in the presence of noise and reduces receiver sensitivity. An agc detector noise limiting circuit offers some help. The narrower bandwidth, however, and the steeper selectivity-skirts, usually employed in ssb, reduce the amplitude of the noise pulses and stretch them out in time, so that it is difficult for the agc noise limiter to discriminate on the basis of amplitude. Moreover, there is no carrier to

automatically set the clipping level. In addition to causing agc line loading, impulse noise also reduces the receiver signal-to-noise ratio. Attempts to use conventional noise limiters at the input or output of demodulator meet the same objection as the agc limiter, because the impulse noise is reduced in amplitude and stretched out in time. In both cases, it is desirable to reduce or eliminate the noise before the bulk of the receiver selectivity. This, in a filter-selectivity receiver, is just before the i-f filter. There are two principal methods of impulse noise reduction. These are silencing or blanking and limiting or clipping.

"A silencer or blanker interrupts the signal for the duration of the noise pulse, removing both signal and noise for a short period of time. In the presence of an a-m carrier, this constitutes downward modulation and produces a spectrum of sidebands, some of which pass through the i-f, are detected and cause a residual audio noise output. In suppressed carrier ssb, there is no carrier to modulate, so the only effect of blanking is to remove small portions of the signal. If the blanking periods are short, these small holes in the signal are imperceptible.

"The second method of reducing noise in the i-f amplifier is by limiting or clipping. Ideally, the clipper would have no effect on the desired signal, but would simply chop off noise-peaks which were higher in amplitude than the signal. In designing a clipper, a choice must be made as to the location of the clipper in the circuit. It is desirable to have sufficient selectivity before the clipper so that it does not chop adjacent-channel signals and produce IM products in the desired signal channel. Clipping should be done before the bulk of the selectivity for much the same reason as blanking. This is particularly important for receivers employing an i-f filter with a flat top and steep sides."

### NEW GOVERNMENT PUBLICATIONS:

The following publications are available through the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C.:

#### Solar Radio Bursts of Spectral Types II and IV: Their Relations to Optical Phenomena and to Geomagnetic Activity:

Smithsonian Contributions to Astrophysics, volume 5, number 15, discusses solar radio bursts of spectral types II and IV, with primary attention to the magnetic type of the associated sunspot, and to the north-south asymmetry in their numbers and durations. Their relation to geomagnetic storms and to solar proton events (PCA) is also explored. 1963. p 239-257, il. Catalog No. SI 1.12/2:5/15 - price 30¢.

#### Radio Frequency Control in Space Telecommunications:

A report on radio frequency control in relation to space telecommunication and research, this study provides explanatory notes on the critical role that radio communication now plays in the exploration of outer space for tracking, for tele-metering of scientific data, and for remote guidance; discusses the growing significance of international administrative control as the only practical means of preventing harmful interference; and directs major attention to the unprecedented agreements on space telecommunication negotiated by the U. S. delegation to the Geneva Radio Conference held under auspices of the International Telecommunication Union. 1960. 235 p. il. Catalog No Y 4.Ae8:R11 - price 75¢.

#### Installation and Maintenance Handbook for Interference Shielding of Internal Combustion Engines:

The Bureau of Yards and Docks provides technical guidance on, and is responsible for, suppression of radio frequency interference caused by equipments and systems under its technical control. Unshielded internal combustion engines are one of the more potent sources of radio frequency interference when operated near antennas of radio receiving devices.

This publication provides the information required to install, test, and maintain suppression shielding on the engines operated in such sensitive areas. Rev. 1963. 47 p. il. Catalog No. D 209.14:Sh 6/2 - laminated cover \$2.25

#### Interference Shielding Catalog for Internal Combustion Engines:

Intended to supplement the above publication, the purpose of this catalog is to provide a complete Bill of Materials of shielding components required to shield a specific group of engines, and to provide cross-referencing to permit the compilation of Bills of Materials on new engines. The shielding components listed are identified by Federal Stock Numbers and are cross-referenced to the manufacturer. Rev. 1963. 199p. Catalog No. D 209. 14:Sh 6/2 - laminated cover \$2.75.

#### NBS Announces Three New Publications:

The National Bureau of Standards announces the publication of three Technical Notes prepared by the Central Radio Propagation Laboratories at the NBS Boulder (Colorado) Laboratories. All three publications are of interest to radio engineers and others engaged in radio propagation.

One Technical Note presents an interpolation procedure for calculating atmospheric band absorption from laboratory data. Another gives a number of electron density profiles obtained at a new location, by use of a relatively new technique. The third Technical Note consists of the current tables of results of radio noise measurements being made in three-month intervals by an NBS network of field stations.

An Interpolation Procedure for Calculating Atmospheric Band Absorptions from Laboratory Data, by LeAnn Dippleman, Lawrence R. Megill, and Robert F. Calfee, National Bureau of Standards Technical Note 178; June 3, 1963; 18 pages; 20 cents. This Technical Note describes an interpolation procedure developed at the NBS Boulder Laboratories for calculating atmospheric band absorptions in the upper atmosphere. Results obtained by this use of laboratory data are reported to agree favorably with the experimental data available.

Profiles of Electron Density over the Magnetic Equator Obtained Using the Incoherent Scatter Technique, by Kenneth L. Bowles, National Bureau of Standards Technical Note 169; March 16th, 1963; 30 pages; 25 cents. This Technical Note presents a number of electron density profiles obtained using incoherent scatter near Lima, Peru.

Quarterly Radio Noise Data--June, July, August 1962, by W. Q. Crichlow, R. T. Disney, and M. A. Jenkins, National Bureau of Standards Technical Note 18-15, March 1, 1963; 78 pages; 45 cents. This Technical Note presents tables of the results of radio noise measurements for the period of June, July, and August 1962, made at 16 field stations in a world-wide network supervised by the National Bureau of Standards. This is the fifteenth in the NBS Technical Note 18 series, which has contained data on similar radio noise measurements covering the entire period since July 1, 1957. The tables are based on three parameters of the noise: (1) the mean power, (2) the mean envelope voltage, and (3) the mean logarithm of the envelope voltage.

The publications may be ordered from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

#### NEW PRODUCTS:

##### Microwave Radiation Hazard Detector

Sperry Microwave Electronics Co., Clearwater, Fla.

#### NEW PRODUCTS:

##### Microwave Radiation Hazard Detector

Sperry Microwave Electronics Company, Clearwater, Florida, has developed a microwave radiation hazard detector from 400 to 10,000 mc which registers unsafe power levels in excess of 10 mw/sq ohms. It is identified as the Microline B86B2 Electromagnetic Radiation Detector FSN 6625-989-1100.

##### Electrically Conductive Graphite Film

Acheson Colloids Co., a Division of Acheson Industries, Inc., Port Huron, Michigan, has brought out an aerosol-dispensed electrically conductive film called "Aerolon G". It is a colloidal graphite in a fast-driving solvent which is useful for applying a conductive path for electrons. Typical applications include shielding, control of static charges, dielectric plating and grid coating. The material has good adherence properties with most metallic and dielectric surfaces and has a typical resistance rating of 5,000 to 30,000 ohms per square unit of measure for a film thickness of 0.0002 inch.

##### Conductive Hard Coat for Aluminum

Materials in Design Engineering, May 1963, page 27, has two letters suggesting above coatings. One suggestion is a copper-silicon carbide material by Melvin V. Stachura, CEM Division, Platecraft of America, Inc., Buffalo, New York, and the other was a metallized coating of aluminum by Ervin Colton, Materials Development - New Products, Allis-Chalmers Mfg. Co., Milwaukee 1, Wisconsin.

##### Emerson & Cuming Offer Two New Products

Eccoshield MAS door with magnetic area seal is an RF shielded door using a new system of RF sealing free of the deficiencies of finger stock. Magnets apply pressure over a broad area of a shielding membrane to make doors or removable panels self-sealing with no mechanism, no effort and no maintenance. Described in Preliminary Technical Bulletin 11-2-12.

Eccoshield SV is highly conductive plastic material which has a volume resistivity in the range of metals and has shown excellent results in insertion loss tests. Described in Preliminary Technical Bulletin 11-2-10. Bulletins may be obtained by writing Emerson & Cuming, Inc. Canton, Massachusetts.

##### New Soldering Flux Offered

Connecticut Valley Chemicals, Inc. 178 Prince Street, New York 12, New York, has developed an innovative flux for the Commercial/Military industry, called "V-13". This liquid soldering flux offers increased production by cutting touch-ups up to 75%. An engineering data sheet is available on request.

##### Magnetic Shield Adds 3 Products

Three product lines have been introduced by Magnetic Shield, division of Perfection Mica Company. These include a container for protecting magnetic tapes; miniature sectional shields made necessary by space limitations, and a magnetic shunt ring collector for protection against the effects of a thyatron's ionization cycle.

Marketed under the names Netic (a low to moderate permeability material) and Co-Netic (a high permeability material), these units restrict the penetration of magnetic fields. The materials are insensitive to shock and have minimum retentivity, the firm claims.

RFI Filter Developed for Telephone and Intercommunication  
Lines in Shielded Enclosures

RF Interonics, Inc., 15 Neil Court, Oceanside, L. I., N. Y., has developed a new type of interference filter designed for use in telephone and intercommunication lines entering shielded enclosures. Extremely high insertion loss is claimed in frequencies from 14 kc to 10,000 mcs while maintaining low attenuation in the pass band. The filter is designed to be installed in a 2 wire, 600 ohm line and is known as Type RF1070. Further information may be obtained from RF Interonics, Inc.

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GE Develops Single-Reversal TWT

A new series of single-reversal permanent-magnet travelling wave tubes with low noise and the capability of close spacing has been developed by General Electric Company.

Functioning as rugged low-noise preamplifiers, the tubes have applications in telemetry systems, advanced radars, and counter-measure systems.

Initially, GE Travelling Wave Tube Product Section, Palo Alto, California, is putting out five X-band tubes in this series. Further X-band and C-band versions are under development. Metal-ceramic construction is used in all types. Prices vary from \$2,700 to \$3,000.

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Rexford Daniels, Editor  
PTG-EMC Newsletter

