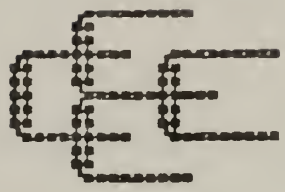
NBSIR 83-2719-1

Center for Electronics and Electrical Engineering



Technical Progress Bulletin

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
National Engineering Laboratory
Center for Electronics and Electrical Engineering

COVERING SIGNALS AND SYSTEMS PROGRAM, OCTOBER 1981 - MARCH 1982

May 1983

U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, *Secretary*
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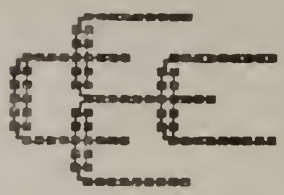
CENTER FOR ELECTRONICS AND ELECTRICAL ENGINEERING



SIGNALS AND SYSTEMS PROGRAM, ISSUE FOR OCTOBER 1981 - MARCH 1982

Introduction

This compilation of abstracts of papers approved for publication by the National Bureau of Standards covers the work of three technical divisions in the NBS Center for Electronics and Electrical Engineering for the first half of the Federal fiscal year, October 1981 through March 1982. These divisions are the Electrosystems Division at Gaithersburg, MD and the Electromagnetic Fields Division and Electromagnetic Technology Division in Boulder, CO. The work of these divisions collectively forms the Signals and Systems Metrology Program of the Center. A compilation of abstracts covering the work of the Signals and Systems Metrology Program for the second half of Federal fiscal year 1982 is available as NBSIR 83-2719-2.

The work of the remaining two divisions of the Center, the Semiconductor Materials and Processes Division and Semiconductor Devices and Circuits Division both at Gaithersburg, comprises the Semiconductor Technology Program. Abstracts covering this work for the entire Federal fiscal year 1982 (October 1981 through September 1982, fifty-third through fifty-seventh quarters of the Program) have been published in January 1983 as NBSIR 82-2636, Semiconductor Technology Program Progress Briefs [single copies available from the Center, see back page for address].

New Publication Covering Entire Center

Beginning with the first quarter of Federal fiscal year 1982 (October through December 1982), the Center is initiating publication of a single document to cover work in both the Semiconductor Technology Program and the Signals and Systems Metrology Program. The new publication will have the same name as the one you are now reading -- CEEE Technical Progress Bulletin -- and replace the STP Progress Briefs series. The primary purpose of the new Bulletin is to provide sponsors and other interested parties abstracts of documents approved for publication as soon as possible. Additional information will be provided on published papers; conference and workshop proceedings; special-format publications, such as magnetic data tapes and videotapes; new measurement services, including calibration services and standard reference materials; and a six-month calendar of Center events.

Publication Lists

Guides to earlier as well as recent work are the publications lists covering the work of each division. These are revised and reissued on an approximately annual basis and are available from the originating division [the publications from the Semiconductor Technology Program are covered in a single list, available from either division]. Readers are encouraged to contact any of the individuals listed on the back page for further information.

SIGNALS AND SYSTEMS METROLOGY PROGRAM, ISSUE FOR OCTOBER 1981 - MARCH 1982

Mission of Signals and Systems Program: The Signals and Systems Program of the Center for Electronics and Electrical Engineering provides national reference standards, measurement methods, supporting theory and data, and traceability to the national standards. The technical areas addressed in the Program are identified in the Table of Contents below.

The metrological products of the Program aid economic growth by promoting equity and efficiency in the marketplace, by removing metrological barriers to improved productivity and innovation, by increasing U. S. competitiveness in international markets through facilitation of compliance with international agreements, and by providing technical bases for the development of voluntary standards for domestic and international trade. These metrological products also aid in the development of rational regulatory policy and promote efficient functioning of technical programs of the Government.

TABLE OF CONTENTS

Note: Abstracts are presented alphabetically by first author within above areas.

Sponsors of Work Covered in this Publication: National Bureau of Standards; NBS Law Enforcement Standards Laboratory; Department of Defense: DoD Calibration Coordination Group, DoD Electromagnetic Compatibility Analysis Center, U.S. Air Force, USAF Newark Air Force Station, U.S. Army, U.S. Navy, USN Naval Systems Research and Development Command, USN Naval Weapons Station, USN Office of Naval Research; Department of Energy, DoE Bonneville Power Administration; Department of Health and Human Services, HHS National Center for Devices and Radiological Health (formerly Bureau of Radiological Health), HHS National Institute of Occupational Safety and Health; Department of Transportation, DoT National Highway Traffic Safety Administration; Electric Power Research Institute; and International Copper Research Association.

FAST SIGNAL ACQUISITION, PROCESSING, & TRANSMISSION

Waveform Metrology

Nahman, N. S., and Guillaume, M. E., **Deconvolution of Time Domain Waveforms in the Presence of Noise**, NBS Tech. Note 1047 (October 1981).

Deconvolution or inverse filtering was used to determine the impulse response of a system using noisy input and output time domain sequences (discrete data). Frequency and time domain methods were studied along with the synthesis of the filters required to obtain stable and smooth results. For the methods studied it was concluded that the superior technique was provided by an optimal frequency domain method implemented via the FFT. Also, it is pointed out that the time domain methods are only in their infancy and still retain the promise of avoiding transform domain filtering. Examples are presented in which the impulse responses are determined in the presence of varying degrees of noise for a coaxial transmission line, a wave-shaping filter, and a broad-band antenna.

Souders, T. M., **A Dynamic Test Method for High-Resolution A/D Converters**, IEEE Trans. Instrumentation and Measurement IM-31, pp. 3-5 (March 1982).

A dynamic test method is described for A/D converters having up to 16 bits of resolution. The technique exercises the test converter with stepped input changes, simulating the output of an S/H amplifier. Dynamic errors as low as 4 ppm can be measured with 4 μs following a step change as large as 20 V.

Cryoelectronic Metrology

Hamilton, C. A., and Lloyd, F. L., **Design Limitations for Superconducting A/D Converters**, IEEE Trans. Magnetics MAG-17, pp. 3414-3419 (November 1981).

This paper reviews the principle of A/D conversion using superconducting quantum interference and describes the results obtained with this technique. At an accuracy of four or six bits the design of such converters is straightforward. Higher accuracy requires careful consideration of numerous design constraints including critical current uncertainty, power supply regulation, turn-on-delay, signal line crosstalk, and the threshold curve critical points. The implications of these constraints are analyzed with respect to an example design for an 8-bit converter.

Goldfarb, R. B., **Miniature Multipin Electrical Feedthrough for Vacuum Use**, Cryogenics, p. 746 (December 1981).

A miniature multipin electrical feedthrough for room-temperature vacuum use is made from commercially available components and an easily machined bushing.

Kautz, R. L., **Chaotic States of rf-Biased Josephson Junctions**, J. Appl. Phys. 52, pp. 6241-6246 (October 1981).

The existence of chaotic solutions to the rf-driven Stewart-McCumber model of a Josephson junction has recently been demonstrated. The present paper describes more fully the range of junction parameters and frequencies for which chaotic solutions occur, details the connection between chaotic states and instabilities in phase-lock, and shows that chaotic noise can be much larger than the thermal noise of a junction.

Peterson, R. L., **Mathematical Modeling of the Impedance of a Josephson Junction Noise Thermometer**, J. Appl. Phys. 52, pp. 7321-7326 (December 1981).

Recent experimental work on noise thermometers consisting of a resistively shunted superconducting loop containing a Josephson junction (a resistive SQUID)

Cryoelectronic Metrology, cont'd.

has shown some novel behavior of the SQUID dc impedance as a function of rf power. We present a mathematical analysis of the intrinsic behavior of a resistive SQUID in the limit of negligible noise and negligible feedback to the rf circuit. A nonlinear, first-order differential equation is thought to be a reasonable descriptor of this system. Because the radio frequency driving the SQUID is much larger than the Josephson frequency, we are able to obtain a pair of equations in which no rf oscillating terms appear, and which are amenable to numerical solution. The dc impedance calculated from these equations has several, but not all, of the experimentally observed features.

Zimmerman, J. E., and Sullivan, D. B., **A Study of Design Principles for Refrigerators for Low-Power Cryoelectronic Devices**, NBS Tech. Note 1049 (January 1982).

This report summarizes a five-year effort at NBS which has been directed toward the development of low-power cryocoolers suited to the support of superconducting instruments. The report deals with a variety of aspects of construction and operation of refrigerators as well as with a model which allows one to optimize the design for minimum drive power. The publications generated by the program are included as an appendix.

Antenna Metrology

Baird, R. C., **Microwave Antenna Measurement Services at the National Bureau of Standards**, Digest, Antenna Measurement Techniques Association Meeting (October 1981).

This paper reviews and summarizes the microwave antenna measurement services presently available at the National Bureau of Standards, Boulder, Colorado. The extrapolation technique, which is used for accurate calibrations of transfer-standard antennas, is described and its limitations pointed out. With this technique, uncertainties of ±0.08 dB to ±0.10 dB in absolute gain and ±0.05 dB/dB in polarization axial ratio are achieved routinely. Accurate antenna evaluations are also accomplished by means of near-field scanning methods developed at NBS. Most of these measurements have utilized planar near-field scanning, but cylindrical scanning capabilities exist. With this technique, complete patterns are determined in addition to absolute gain to an accuracy of ±0.15 dB and polarization axial ratio to ±0.10 dB. Side lobes can be obtained down to -50 dB to -60 dB with a typical accuracy of ±1.0 dB at the -40 dB level. Examples of measurement results for several different types of antennas are given. Finally, NBS capabilities for measuring the G/T of earth terminals and the thermal noise properties of sources and antennas are mentioned briefly.

Estin, A. J., Stubenrauch, C. F., Repjar, A. G., and Newell, A. C., **Optimized Wavelength-Sized Scalar Horns as Antenna Radiation Standards**, IEEE Trans. Instrumentation and Measurement IM-31, pp. 53-56 (March 1982).

The properties of beamwidth, directivity, and polarization of wavelength-size scalar horns are analyzed and optimized theoretically and confirmed experimentally to determine the usefulness of such horns as standards. Agreement between theoretical predictions and measurements was good.

Hill, D. A., and Wait, J. R., **HF Ground Wave Propagation Over Mixed Land, Sea, and Sea-Ice Paths**, IEEE Trans. Geoscience and Remote Sensing GE-19, pp. 210-216 (1981).

Ground wave propagation is analyzed for a two-section path on a spherical earth. Each section can be a two-layer medium which is characterized by a surface impedance. Specific calculations for a land-to-sea path indicate that the well-

Antenna Metrology, cont'd.

known recovery effect in amplitude and phase is more extreme at higher frequencies but is reduced for elevated observer heights. Calculations for a sea-to-sea ice path indicate a brief recovery because of the excitation of the trapped surface wave over sea ice. At greater distances from the boundary, the field may be seriously degraded due to the sea ice.

Ma, M. T., **Synthesis of Broadband Antenna Arrays as Possible Over-The-Horizon Radars**, Chapter 9 in book, Research Topics in Electromagnetic Wave Theory, J. A. Kong, Ed. (John Wiley & Sons, New York), 1981.

Based on the requirements of broadband operation and other radiation characteristics, the side-terminated vertical half rhombic is selected as the antenna element in an array to be included as the central part of an over-the-horizon radar, which serves as a remote means for sea study. A nonuniformly spaced array of 25 elements is synthesized for the entire high-frequency band. The array has the capability of providing a maximum transmitting-receiving product gain in the order of 60 dB at low take-off angles, a product azimuth pattern with a nominal half-power beamwidth of 2°, a product sidelobe level of -38 dB, and a grating-lobe level of at least -30 dB, and of covering an approximate range of 3,000 km and a sector area of 40°.

Yaghjian, A. D., **Efficient Computation of Antenna Coupling and Fields Within the Near-Field Region**, IEEE Trans. Antennas and Propagation AP-30 (January 1982).

This paper presents the theory, explains the techniques, details the important equations, and describes two computer programs for calculating efficiently the mutual coupling at a single frequency between any two antennas arbitrarily oriented and separated in free space. Both programs emphasize efficiency and generality, and require, basically, the complex electric far field of each antenna, and the Eulerian angles designating the relative orientation of each antenna. Multiple reflections between the antennas are neglected but no other restrictive assumptions are involved. If an electric field component is desired instead of coupling, the receiving antenna is replaced by a virtual antenna with uniform far field.

The first computer program computes coupling (or fields) versus transverse displacement of the antennas in a plane normal to their axis of separation. An efficient FFT program was made possible by "collapsing" the far-field input data and showing that in most cases the spectrum integration need cover only the sheaf of angles mutually subtended by the smallest spheres circumscribing the antennas. Limiting the integration to this sheaf of angles artifically band limits the coupling function, thereby allowing much larger integration increments and reducing run times and storage requirements to a feasible amount for electrically large antennas.

The second program is based on a spherical wave representation of the coupling function and rapidly computes coupling (or fields) versus separation distance between the antennas. The spherical wave representation emerged naturally from an intriguing characteristic proven for the mutual coupling function; it, like each rectangular component of electric and magnetic field in free space, satisfies the homogeneous wave equation.

Noise Metrology

Counas, G., and Bremer, T., **NBS 30/60 Megahertz Noise Measurement System Operation and Service Manual**, NBSIR 81-1656 (December 1981).

Calibration of coaxial noise sources at 30 and 60 MHz is now being accomplished using a total power radiometer designed to operate under computer control. Use

Noise Metrology, cont'd.

of the IEEE 488 instrument Bus and structured software techniques allows use and substitution of commercially available components with a minimum of hardware and software modification.

This manual addresses the general theory of operation, operating procedures, and maintenance procedures for the NBS 30/60 MHz automated noise measurement system using a commercially available desktop calculator as the controller.

Wakefield, J. P., **Addendum to Earth Terminal Measurement System Maintenance Manual**, NBSIR 81-1641 (October 1981).

This addendum to the Earth Terminal Measurement System Maintenance Manual, NBSIR 78-895, describes the equipment and maintenance procedures required to support the retrofit package for the Earth Terminal Measurement System (ETMS) developed by the National Bureau of Standards. This retrofit adds a multi-input-port relay module which provides the capability of connecting three receiver channels to the ETMS, thereby enabling measurement of pertinent earth terminal parameters at as many as three frequencies in a single measurement pass. This manual does not include measurement theory nor measurement operating procedures that are described in the Earth Terminal Measurement System Operation Manual, NBSIR 78-879.

Microwave & Millimeter-Wave Metrology

Hoer, C. A., **A High-Power Dual Six-Port Automatic Network Analyzer Used in Determining Biological Effects of RF and Microwave Radiation**, IEEE Trans. Microwave Theory & Techniques MTT-29, pp. 1356-1364 (December 1981).

The design, calibration, and performance of a high-power (1-1000 W) automatic network analyzer based on the six-port concept are described for the 10-100 MHz range. Calibration is performed with a length of transmission line as the only impedance standard needed. A 10-mW thermistor mount is the standard of power. Imprecision in measuring reflection coefficient Γ is 0.0001 in magnitude and $0.005/|\Gamma|$ degrees in phase. Corresponding estimated systematic errors are 0.001 and $0.1/|\Gamma|$ degrees. Imprecision in measuring power is 0.01 percent of range (20 W, 200 W, or 1000 W) with an estimated systematic error of 1.25 percent of reading.

Laser Metrology

Simpson, P. A., and Zimmerer, R. W., **A Water-Cooled 2 kW Calorimeter for Laser Power Measurement**, Proc. Electro-Optics/Laser 81 Conf., Anaheim, California, November 17-19, 1981, pp. 237-239.

To meet the growing need for reliable monitoring of industrial high power CO_2 lasers, a calorimeter was designed to be both easily used, reliable, and accurate. A maximum continuous power input of 2 kilowatts was specified in order to handle commonly used CO_2 lasers.

A 5.7-cm diameter copper tube 61 cm long traps the incident laser beam and absorbs it in a series of internal reflections. A 4.8-mm copper tube wound around the outside carries a 1 liter per minute water flow. A manganin wire interwinds the cooling coil and is bonded to the 5.7-cm absorbing tube to provide substitution electrical heat for realistic calibration. Power is measured by the rise in the temperature of the cooling water as indicated by a thermopile.

Two different measurement methods are discussed. First results indicate a sensitivity of 7.8 W/mV. The 1/e response time is approximately 6 s.

Young, M., **Use of LEDs as YAG Laser Simulators**, Proc. Electro-Optics/Laser 81 Conf., Anaheim, California, November 17-19, 1981, pp. 222-229.

Laser Metrology, cont'd.

There is wide interest in using light emitting diodes (LEDs) for calibrating and testing detectors designed to measure weak, diffuse YAG laser beams. Differences of coherence and possible other differences have given rise to the question, is such use of an LED either practically or theoretically justifiable? The purpose of this paper is to examine the problem in some detail and to determine if possible the conditions under which suitably filtered LED radiation will adequately simulate a laser beam. We conclude that, although there are certain areas that require special care, use of an LED as a laser simulator is entirely feasible.

Optical Fiber Metrology

Danielson, B. L., **Backscatter Signature Simulations**, NBS Tech. Note 1050 (December 1981).

This report presents a collection of computer-generated backscatter signatures which represent realistic replicas of signals that can be encountered in optical time-domain reflectometer (OTDR) systems. Emphasis is placed on illustrating the appearance of backscatter signatures originating from localized and distributed imperfections which are superimposed on an otherwise uniform optical fiber. The details of these signatures are shown to be a function of the particular type of fiber perturbation, experimental parameters, and data reduction methods. This compilation of simulated responses is intended to facilitate the correct interpretation of OTDR signals as well as to point out sources of error which can arise in the characterization of optical fibers using backscatter techniques.

Franzen, D. L., and Kim, E. M., **Long Optical-Fiber Fabry-Perot Interferometers**, Appl. Optics 20, pp. 3991-3992 (December 1981).

A Fabry-Perot Interferometer using single-mode optical fibers is described. A finesse of 14 was obtained for fiber lengths of a few meters.

Gallawa, R., **Optical Waveguide Communications Glossary**, NBS Handbook 140 (January 1982).

Revision of NTIA Special Publication SP 79-4 dated September 1979.

Gallawa, R. L., Book Review: **Optical Fibre Communication**, IEEE Spectrum 18, pp. 81-82 (November 1981).

Review of McGraw-Hill text, prepared by the technical staff of CSELT, Torimo, Italy.

Kim, E. M., and Franzen, D. L., **Measurement of the Core Diameter of Graded-Index Optical Fibers: An Interlaboratory Comparison**, Appl. Optics 21, pp. 3443-3450 (October 1982).

An interlaboratory measurement comparison of optical fiber core diameter was conducted by the National Bureau of Standards (NBS) in cooperation with the Electronic Industries Association. Participants include NBS and three fiber manufacturers. Six graded-index fibers were measured by all participants using the transmitted near-field method. As a group, the transmitted near-field measurements were consistent and exhibited an average standard deviation of 0.5 μm for 50-μm core fibers. These results were also compared to diameters determined by refracted near-field and transverse interference measurements contributed by other laboratories. For smooth-index profiles, all three methods agree within ~1 μm; substantial differences between the transmitted near-field and the other two methods can exist for fibers having step structure near the core-cladding boundary.

Young, M., Book Review: **Principles of Optical Fiber Measurements**, Laser Focus 18, pp. 118-119 (January 1982).

Optical Fiber Metrology, cont'd.

Review of Academic Press (New York) text by Dietrich Marcuse.

Young, M., **Optical Fiber Index Profiles by the Refracted-Ray Method (Refracted Near-Field Scanning)**, Appl. Optics 20, pp. 3415-3422 (October 1981).

This paper provides an elementary description and tutorial overview of the refracted-ray method of measuring fiber index profiles. It also presents new results concerning the theoretical foundation, the linearity and precision, and other aspects of the method. In particular, we find that index differences may be measured to 5% or better and conclude by showing ~3% agreement with another laboratory and good agreement with numerical aperture measurements performed by participants in an interlaboratory comparison.

Other Fast Signal

Kamper, R. A., **Current Trends in NBS Calibration Services**, NCSL Newsletter 22, pp. 38-39 (March 1982).

Recently, the management of NBS has given close attention to calibration services and has started several actions to improve quality and responsiveness for the future.

Larson, D. R., **A Measurement Method for Determining the Optical and Electro-Optical Properties of a Thin Film**, NBSIR 81-1652 (December 1981).

A method of determining the complex refractive index of a thin film on a nonabsorbing substrate is developed. The optical transmittance spectrum of the structure is measured and the index is determined by matching this spectrum numerically. An iterative procedure for finding the magnitude of an induced change in refractive index is also presented. In nonabsorbing spectral egions, the index and film thickness are determined directly.

The optical transmittance of sapphire and thin films of gold and epitaxial silicon, both on sapphire, is examined. The refractive index of epitaxial silicon on sapphire, SOS, is determined and compares favorably with the results of other investigators.

The measurement method is applied to a thin film of hydrogenated amorphous silicon, deposited by a capacitively-coupled rf glow discharge. The index is tabulated for various wavelengths and a field induced change in index comparable to that seen in GaAs is measured.

Young, M., **Quantum Noise Limits the Pinspeck Camera to Simple Objects**, J. Optical Society America 72, pp. 402-403 (March 1982).

The pinspeck camera projects a low-contrast image with a great deal of veiling glare. Quantum noise determines that the camera can image only simple objects that contain no more than a few hundred picture elements.

ELECTRICAL SYSTEMS

Power Systems Metrology

Kelley, E. F., and Hebner, R. F., **Electro-Optic Measurement of the Electric Field Distribution in Transformer Oil**, to be published in IEEE Trans. Power Apparatus & Systems.

A system has been developed to measure the electric fields in transformer oil using the electro-optic Kerr effect. The system performance was verified by measuring the electric field and space charge in nitrobenzene. The field distributions were measured in clean oil, in oil which had been used as a wash for a radiator used in a power transformer, and in oil which was removed from a transformer that had failed. Measurements were made from room temperature to 100°C. Under the conditions studied, the electric field strengths were

Power Systems Metrology, cont'd.

generally within 10% of the strengths that would be predicted assuming that space charge was negligible.

McKnight, R. H., Kotter, F. R., and Misakian, M., **Measurement of Ion Current Density at Ground Level in the Vicinity of High Voltage DC Transmission Lines**, NBSIR 81-2410 (December 1981) [similar material to be published in IEEE Trans. Power Apparatus and Systems].

Sensors for measuring vertical current density at ground level near high voltage dc (HVDC) transmission lines are subject to error when the sensor is not in the ground plane. The magnitude of this error, for guarded and unguarded sensors, has been investigated using both dc electric fields with space charge and ac electric fields in a parallel plate facility. For conditions like those expected under HVDC transmission lines, the results obtained using ac and dc methods agreed to within experimental uncertainty. The measured errors are as large as 25% for guarded sensors and significantly larger for unguarded sensors. Data for various sensor elevations and guarding are presented in graphs to aid the designer.

Schmidt, W.F., and Van Brunt, R.J., **Comments on the Effect of Electron Detachment in Initiating Breakdown in Gaseous Dielectrics**, Proc. Third Int. Symposium on Gaseous Dielectrics, Knoxville, Tennessee, March 7-11, 1982, pp. 561-563.

This paper represents a summary of the deliberations of a small group discussion meeting held at the Third International Symposium on Gaseous Dielectrics. The relative importance of various electron detachment processes in the initiation of electrical breakdown in electronegative gases is considered and discussed.

Van Brunt, R.J., **Effects of H_2O on the Behavior of SF_6 Corona**, Proc. Seventh Int. Conference on Gas Discharges and Their Applications, London, England, August 31 - September 3, 1981, pp. 255-258.

The effects of trace amounts of H_2O vapor (<300 ppm) on point-to-plane dc-corona inceptions and corona pulse characteristics in SF_6 were investigated. Corona discharges were generated in short gaps, 1.0 to 3.0 cm, for sharp point electrodes of diameter ~0.1 mm, and for gas pressures in the range of 100 to 400 kPa. Trace levels of H_2O were introduced by electrical heating of a wire in the gas, and its concentration was monitored with a gas chromatograph-mass spectrometer. Water vapor was found to significantly enhance the intensity of corona at a given voltage, as indicated by an order of magnitude or more increase in average discharge current and corona pulse rate. The presence of small quantities of H_2O greatly inhibits formation of positive streamer burst pulses and significantly modifies the shape of the corona pulse height distribution. On the other hand, introduction of H_2O results in only a slight reduction in the overall dielectric strength of SF_6.

Van Brunt, R. J., and Leep, D. A., **Corona-Induced Decomposition of SF_6**, Proc. Third Int. Symposium on Gaseous Dielectrics, Knoxville, Tennessee, March 7-11, 1982, pp. 402-409.

The stable, neutral decomposition products resulting from posititive point-plane dc-corona in static SF_6 gas have been identified with a gas chromatograph-mass spectrometer. Absolute concentrations of some species have been measured with a sensitivity of ~1 ppm as a function of total energy dissipated for discharge power levels between 50 and 700 mW. The first detectable gaseous contaminant to appear

Power Systems Metrology, cont'd.

is H_2O, presumably liberated by discharge-induced desorption from the electrode. The oxyfluorides SOF_2, SO_2F_2, and SOF_4 are the next most prominent species to appear. Other species such as CO, CO_2, CF_4, OCS, and SO_2 were identified. For corona levels below 700 mW, SOF_2 and SO_2F_2 appear with nearly equal concentrations, and the production rates for both are constant and proportional to discharge power. The presence of trace amounts of H_2O and other decomposition products is found to have a pronounced effect in suppressing the pulse burst characteristic of positive corona in SF_6.

Pulse Power Metrology

Hebner, R. E. and Hagler, J. N., **Discussion of 82 WM 255-8, Reconstruction of High Impulse Voltages Considering the Step Response of the Measuring System**, to be published in IEEE Trans. Power Apparatus & Systems.

This discussion requests from the authors of the original paper further information about the accuracy of and the distinctions between the two deconvolution algorithms describe in the original paper.

Magnetic Materials and Measurements

Fickett, F. R., **Electrical Properties of Materials and Their Measurement at Low Temperatures**, NBS Tech. Note 1053 (March 1982).

A review is given of the electrical resistance of materials at cryogenic temperatures. Measurement techniques, the data base, and uses of the data are presented. The emphasis is on metals and alloys of technological importance; a topic which covers a large range of materials. Similarly, the treatment of theory and of measurement techniques is primarily for the user interested in the more practical aspects of the subject. In every instance, however, references are given which allow the reader to pursue the subject at any level.

Fickett, F. R., **Electrical and Magnetic Properties of Internally Oxidized Copper and Dilute Copper-Iron Alloys**, J. Phys. F: Met. Phys. 12, pp. 1753-1769 (January 1982).

Results are presented on studies for developing an understanding of the process by which the resistive contribution of transition metal impurities, primarily iron, in copper is removed by internal oxidation. The majority of the investigations were made on a CuFe alloy series of precisely determined composition from 1 to 100 atomic parts per million (at PPM) Fe. Electrical resistance and magnetic susceptibility measurements at room temperature and at 4 K on both unoxidized and oxidized samples are reported. These measurements, supported by scanning electron microscopy (SEM) and Curie temperature determinations, suggest a two-step internal oxidation process at even the lowest impurity levels.

Goldfarb, R. B., Rao, K. V., Chen, H. S., and Patton, C. E., **Further Evidence for a Spin-Glass Phase Transition in Amorphous Fe-Mn-P-B-Al Alloys**, J. Appl. Phys. 53, pp. 2217-2219 (March 1982).

Low field dc susceptibility, thermoremanent magnetization, and hysteresis studies are presented for two amorphous Fe-Mn-P-B-Al alloys of concentrations close to, and on either side of, the multicritical point in the magnetic phase diagram. They exhibit spin-glass and para-ferro-spin-glass transitions, respectively. For the spin-glass alloy, the Edwards-Anderson-type order parameter deduced from the dc susceptibility is found to yield a mean-field-valued critical exponent. In the alloy with two magnetic transitions, the temperature dependence of the thermoremanence and hysteresis indicate a ferro-spin-glass transition temperature consistent

Magnetic Materials & Meas., cont'd.

with that deduced from a scaling approach for the same alloy system.

Superconductors

Ekin, J. W., Sekine, H., and Tachikawa, T., **Effect of Strain on the Critical Current of Nb-Hf/Cu-Sn-Ga Multifilamentary Superconductors**, J. Appl. Phys. 52, pp. 6252-6256 (October 1981).

The critical current of multifilamentary Nb-Hf/Cu-Sn-Ga has been determined as a function of both field and strain at fields from 4 to 19 T. The strain dependence of the critical current is significantly decreased compared with that of commercial multifilamentary Nb_3Sn superconductors. This reduced strain sensitivity, coupled with an enhanced critical-current density above 12 T, make this a candidate material for economic high-field magnet construction. An analysis of the data in terms of the strain scaling law indicates that the Hf and Ga additives do not produce this improvement through a decrease in the strain sensitivity of the bulk upper critical field B^*_{c2}. Rather, they reduce the strain sensitivity of the critical current through a changed shape of the flux pinning curve and an enhancement in the strain-free maximum value of B^*_{c2} (B^*_{c2m} = 25 T for Nb-Hf/Cu-Sn-Ga vs. 21 T for Nb_3Sn).

Fickett, F. R., **Electric and Magnetic Properties of CuSn and CuNi Alloys at 4 K**, Cryogenics, pp. 135-138 (March 1982).

Results of low-temperature resistivity, magnetoresistivity, and magnetic susceptibility measurements on CuSn and CuNi alloys of compositions commonly used in practical superconductors are presented and discussed.

ELECTROMAGNETIC INTERFERENCE

Chew, H., **Modeling of Oil Shale Retorts for Electromagnetic Sensing Techniques**, NBSIR 81-1653 (November 1981).

We report here some work on the modeling of oil shale retorts for electromagnetic sensing techniques. The aim is to obtain useful information about the contents of the retort (e.g., rubble size, void ratio, etc.) by means of electromagnetic probes. In this work, the retort is modeled by a spheroid with an average dielectric constant which depends on the void ratio. The near field due to a radiating dipole source in the vicinity of a spheroidal retort is computed using the Extended Boundary Condition Method due to Waterman, Barber, and Yeh. Numerical results are given at 4 MHz for a retort with major axis 45.7 m (150 ft.), minor axis 25.1 m (82.5 ft.), bulk dielectric constant 8.8 + 3.7j, and various void ratios. The results indicate feasibility of determining the void ratio by remote electromagnetic measurements. This work may be of interest beyond the immediate context of oil shale retort modeling.

Crawford, M. L., **Options to Open-Field and Shielded Enclosure Electromagnetic Compatibility Measurements**, Proc. Int. EMC Symposium, Zurich, Switzerland, March 10-12, 1981.

This paper discusses optional measurement techniques that are being investigated as potential alternatives to using open-field sites and conventional shielded enclosures for performing EMC measurements. Techniques discussed include: 1) low-Q underground or buried test chambers, 2) transverse electromagnetic (TEM) transmission line cells, and 3) reverberating or mode tuned/stirred enclosures.

ELECTROMAGNETIC INTERFERENCE, cont'd.

Ma, M. T., and Arthur, M. G., **A Study of Distribution of Electromagnetic Fields Inside Buildings with Apertures Excited by an External Source**, NBSIR 82-1659 (February 1982).

Two special cases of the penetration of electromagnetic fields into a cavity, building or box are formulated and analyzed. One is to consider the case of a lossy cavity with small apertures in free space, based on an application of the equivalence principle and the use of a generalized network formulation. It is found that the field strength at the aperture center is approximately inversely proportional to the square-root of the conductivity of the cavity walls and that high field levels can exist inside the cavity under certain physical conditions. The second case is to treat the problem of large buildings with large apertures on a practical lossy ground by a combination of theoretical approach and measurement data. Field levels inside the building for this latter case depend on the transmitter power, the transmitter-to-building distance, the ground conductivity, and the measurement antenna height relative to that of the transmitter.

Taggart, H. E., **Methods of Suppressing Automotive Interference**, NBS Spec. Publ. 480-44 (November 1981).

The purpose of this report is to review the sources of electromagnetic interference (EMI) within a vehicle so that the reader will have a basic understanding of the EMI problem, discuss the techniques that have been used successfully by the auto industry to suppress EMI, and suggest some newer techniques for suppressing EMI within an automobile.

The automotive manufacturers utilize several techniques to reduce EMI emanating from the vehicle. These techniques include, but are not limited to, resistor spark plugs, resistor spark plug cables, use of silicon grease in the distributor, use of capacitors as filters, placement of grounding straps at key locations, conductive fan belt discharge, and grounding in wheels to reduce tire static-charge build-up. If further reduction of EMI is needed to obtain full utilization of a mobile communication system, there are additional suppression techniques that can be employed to achieve this goal. These are listed. Most of these techniques are effective at frequencies from approximately 30 to 1000 MHz. Measurement results show that the EMI from a new production-line automobile, as measured in accordance with SAE Standard J551g, can be reduced by an additional 10 to 15 dB by employing these additional suppression techniques. A measurement technique is described whereby the amount of degradation to a mobile narrowband FM receiver (used by law enforcement agencies) can be measured. This same technique can then be used as a tool to further reduce EMI from the vehicle.

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All technical information included in this document has been approved for publication previously.

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

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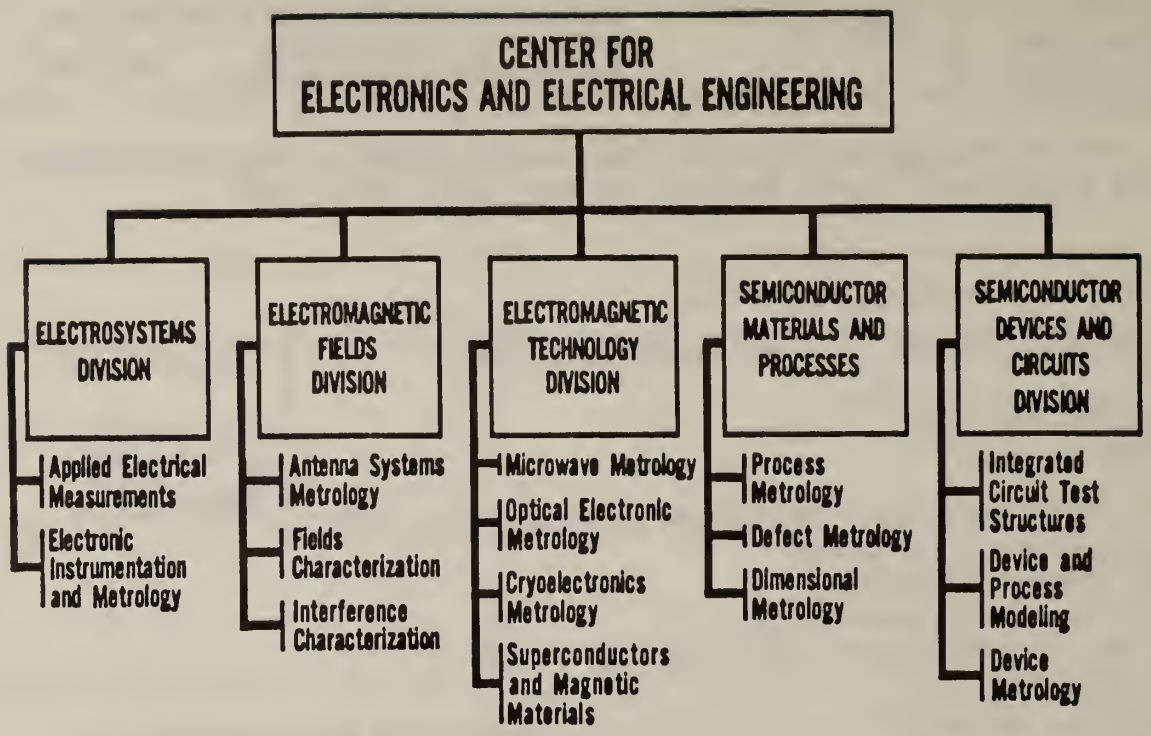

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