Asia–Pacific Abstracts

Papers from Journals Published in Australia, India, China, Korea, and Japan in 1997

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The periodicals investigated are 1) *Journal of Electrical and Electronics Engineering (JEEE),* Australia, 2) *Journal of the Institution of Electronics and Telecommunication Engineers (JIETE),* India, 3) *Acta Electronica Sinica (AES),* China, 4) *Journal of China Institute of Communications (JCIC),* China, 5) *Journal of Infrared and Millimeter Waves (JIMW),* China, 6) *Journal of Applied Science (JAS),* China, 7) *Journal of Electronics (JE),* China, 8) *Journal of Microwaves (JM),* China, 9) *Chinese Journal of the Radio Science (CJRS),* China, 10) *Journal of the Chinese Institute of Engineering (JCIE),* Taiwan, 11) *Journal of the Korean Institute of Telematics and Electronics (JKITE),* Korea, 12) *Journal of the Korean Institute of Communication Science (JKICS),* Korea, 13) *Transactions of the Institute of Electronics, Information, and Communication Engineers (Trans. IEICE),* Japan, 14) *IEICE Transactions on Communications (IEICE Trans. Commun.),* Japan, and 15) *IEICE Transactions on Electronics (IEICE Trans. Electron.),* Japan.

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As for the Japanese papers in the *Trans. IEICE* that carry volume numbers J80-B-II and J80-C-1, short English summaries are found in the *IEICE Trans. Commun.,* vol. E80-B and *IEICE Trans. Electron.,* vol. E80-C, issued in the same month. Papers carrying volume numbers E79-B and E80-C are papers originally written in English. These issues are published by the IEICE Kikai-Shinko-Kaikan, 3-5-8, Minato-ku, Tokyo, 105 Japan.

The full translations of some Japanese papers will appear in *Electronics and Communications in Japan,* published by Scripta Technica, Inc., John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158. The 1996 issues (nos. 5 and 6) of the *JIETE* which were not available last year are included in the present Asia–Pacific Abstracts. Also, the 1997 issues (no. 5 and 6) of the *JIETE* are not available in Japan at the deadline of the Asia–Pacific Abstracts and will be reported next time. The abstracts of these papers are grouped as follows:

1) solid-state microwave devices and MMIC's;
2) transmission lines and passive microwave devices;
3) microwave antennas;
4) microwave/lightwave propagation and scattering;
5) microwave medical/biological applications;
6) lasers and other devices;
7) optical fibers/waveguides;
8) superconductive devices;
9) special issues related to microwave theory techniques (only the titles and their authors).

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I. Solid-State Microwave Devices and MMIC's

(1) Research of Ku-Band Non-Dissipative MESFET Mixer MMIC's, by Y.-X. Sun,* B.-X. Gao,** and J.-T. Lin*** (*Beijing Microelectronics Technology Institute, Beijing, P.R.C.; **Tsinghua University, Beijing, P.R.C.; ***Nanjing Electronic Devices Institute, Nanjing, P.R.C.): *AES,* vol. 25, no. 8, pp. 28–32, Aug. 1997.

Analysis on the principle of non-dissipative MESFET drain mixer circuit has been made. The *Ku*-Band nondissipative MESFET mixer MMIC's have been designed and manufactured. The measurement results are in good agreement with computation. The mixer performs -2 dB of conversion gain and $7 \sim -8$ dB of noise figure.

(2) L- and S-Band High-Performance Narrow-Band Active Filters, by S.-H. Ye, Y.-Y. Chen, X.-W. Zhu, and W. Hong (Southeast University, Nanjing, P.R.C.): *JCIC,* vol. 18, no. 4, pp. 32–36, Apr. 1997.

This paper describes a method using transistors or FET's to obtain high-Q inductors, which are used in the resonators of narrow-band active filters at L and S band. Two high-performance active filters have been developed: one has the measured bandwidth of 90 MHz with the center frequency of 2.3 GHz, and 0 dB of insertion loss in the pass band: the other one is center frequency tunable, which has the measured bandwidth of 80 MHz centered on 1.5 GHz and has 10-dB insertion gain in the pass band.

(3) Two-Dimensional Numerical Simulation of Millimeter-Wave High-Electron Mobility Transistor, by X.-H. Zhang, Y.-F. Yang, and Z.-G. Wang (Laboratory of Semiconductor Materials Science, Institute of Semiconductors, Chinese Academy Sciences, Beijing, P.R.C.): *JIMW,* vol. 16, no. 3, pp. 226–230, June 1997.

A two-dimensional numerical model was presented for the high-electron mobility transistor (HEMT). The physical properties of two-dimensional electron gas in the quantum well of GaAs channel layer for AlGaAs/GaAs HEMT were discussed. The electron concentration and the electric field in the channel were obtained by solving the *Schrödinger's* and Poisson's equations self-consistently. The simulation results show that the transconductance of HEMT changes obviously with the voltage of gate.

(4) Effects of Displaced P–N Junction of HBT, by Y.-M. Zhang,* Y.-M. Zhang,* and J.-S. Luo** (*Microclectronics

Institute of Xidian University, Xi'an, P.R.C.; **Microelectronics Department of Xi'an Jiaotong University, Xi'an, P.R.C.): *JAS*, vol. 15, no. 4, pp. 429–435, Dec. 1997.

The hydrodynamic transport model is used to simulate the effects of displacement of P–N junction of HBT. The electric characteristics are shown to be drastically altered due to changes in the potential profiles and in recombination in both neutral base and space-charge region of the emitter. The effects of a small displacement of the P–N junctions from the emitter-base are examined and results for current gains and cutoff frequencies are given.

(5) A Statistical Model of Microwave FET S-Parameter Using Factor Analysis, by Y. Huang and C.-Y. Shen (Southeast University, Nanjing, P.R.C.): *JE*, vol. 19, no. 1, pp. 77–82, Jan. 1997.

The factor analysis method is first used to establish a S-parameter statistical model of microwave FET's. This statistical model is compared with the one established by principal component analysis method. The results show that the statistical model by factor analysis is more accurate than that by principal component analysis.

(6) Finite-Element Analysis of the SOI Structure M–Z Interferometric Modulator, by C.-Z. Zhao, E.-K. Liu, G.-Z. Li, Y. Gao, and X.-D. Liu (Xi'an Jiaotong University, Xi'an, P.R.C.): *JE*, vol. 19, no. 1, pp. 141–144, Jan. 1997.

A new method for analyzing SOI (silicon-on-insulator) structure Mach–Zehnder interferometric modulator by using finite-element method is put forward. On the basis of the theory of the single-mode SOI rib optical waveguides with large cross section, the electro-optic modulating mechanism of the modulator is investigated by using the plasma dispersion effect, and the electrical characteristics of the device is analyzed by the finite element method at p^+n junction large injected.

(7) Highly Efficient Power Combining Circuit and the Method of Analysis, by S.-Y. Lin (National Laboratory of Antenna and Microwave Technology, Nanjing Research Institute of Electronics Technology, Nanjing, P.R.C.): *JM*, vol. 13, no. 2, pp. 103–107, June 1997.

This paper describes a novel power-combining circuit with high combing efficiency when the magnitudes and phases of the power amplifiers are different or some of the power amplifiers fail. A four-power amplifier combining circuit is given as an example. The circuit parameters are shown and the method of analysis is demonstrated.

(8) Development of 750-MHz CATV Amplifier Module Using PHEMT's, by J. H. Yoo,* K. H. Koo,* S. Cho** (*Dept. of Elec. Eng., Inchon Univ., Inchon, Korea; **Microwave Comm. and Components Inc., Korea): *JKICS*, vol. 22, no. 1, pp. 72–80, Jan. 1997.

A 750-MHz CATV amplifier module has been designed and fabricated using PHEMT chips on alumina board. Developed 2-stage push–pull amplifier using wire bonded PHEMT chips shows 19-dB gain, 15-dB return loss, and 4.2-dB noise figure over the 50–750 MHz frequency range. These results are superior to the characteristics of the commercially available 750-MHz amplifier module. In this paper, a brief background of the amplifier design, the circuit diagram, and the test result have been presented.

(9) A Study on the Design Technologies for the 1-stage 23-GHz LNA's, by D. P. Chang and D. S. Ahn (ETRI, Taejon, Korea): *JKICS*, vol. 22, no. 5, pp. 974–980, May 1997.

The 23-GHz 1-stage LNA was designed by using MPIE numerical analysis and conventional design EEsof softwares. The circuit was designed using conventional tools but analyzed and modified by using numerical MPIE tools. The matching sections was designed with parallel coupled filter-type, which gives impedance matching and dc blocking and has small discontinuities. The FET chip is directly attached to the ground metal. The designed LNA gives 5.8-dB gain and 2.5-dB noise figure without considering the loss and impedance shift of connectors that degenerate the gain and noise figure considerably. This results gives very promising characteristics for our design process and matching schemes and fabrication technologies.

(10) Design of Millimeter-Wave Ultra-Compact Broad-Band MMIC's Amplifiers, by Y. W. Kwon (Dept. of Elec. Eng., Seoul Nat'l Univ., Seoul, Korea): *JKICS*, vol. 22, no. 8, pp. 1733–1739, Aug. 1997.

An ultra-compact millimeter-wave broad-band MMIC's amplifier was designed using a direct-coupled topology combined with optimum feedback design. Significant reduction in the chip size was possible by employing the direct-coupled topology. Bias resistors required for the direct-coupled topology were also used as feedback elements. Feedback was optimized for millimeter-wave frequencies using reactive elements. The fabricated MMIC's amplifier was realized in a chip size of 0.8 mm^2 and showed gains higher than 8 dB from 12 to 44 GHz. An output power of 30 mW was achieved at 44 GHz with a drain efficiency of 10%.

(11) Design of Asymmetrical Coupled Microstrip Directional Coupler on Composite Dielectric Substrates, by S. C. Moon (Dept. of Info. and Comm. Youngdong College, Youngdong, Korea): *JKICS*, vol. 22, no. 9, pp. 1949–1956, Aug. 1997.

The mode parameters of asymmetrical coupled microstrip, lines on composite substrates are derived by using closed-form expression. A 10-dB directional couplers, where the center frequency is 1.8 GHz, are fabricated on a single-layer substrate and on composite substrates, respectively. It is shown that a directional coupler on composite substrates leads to better directivity and wide bandwidth than a directional coupler on a single-layer substrate.

(12) The Fabrication of Microwave Circulator using Polycrystalline $Y_2.4Ca_0.3Sn_0.3Fe_{5-x}Al_xO_12$ Garnets, by J. R. Park, T. H. Kim, M. S. Kim, and J. W. Hahn (Lab. of Comm. Components, ETRI, Taejon, Korea): *JKICS*, vol. 22, no. 11, pp. 2573–2584, Nov. 1997.

In this paper, Ca, Sn substituted YIG (yttrium iron garnet) ceramics were fabricated with Al substitutions in Fesites. The strip-line circulator was designed and the properties of fabricated circulator were measured.

When the electric, magnetic and microwave properties were measured in Ca, Sn substituted YIG with Al substitutions, the relative permittivity and permeability in microwave frequencies were 15.623 and 0.972, respectively. For $Y_{2.4}Ca_{0.3}Sn_{0.3}Fe_{3.8}Al_{1.2}O_{12}$ garnet ceramics sintered at 1450°C, the ferrimagnetic resonance line width (ΔH) of 42

Oe and the saturation magnetization of 487 G were measured at 10 GHz.

The strip-line circulator was simulated with 3-D FEM (finite-element method) software and designed to have insertion loss of 0.8 dB, return loss of 25 dB, and isolation of 35 dB at the center frequency of 1.9 GHz. The fabricated strip-line junction circulator using above YIG ceramics had insertion loss of 0.869 dB, return loss of 26.955 dB, and isolation of 44.409 dB at the center frequency of 1.9 GHz.

(13) Design and Fabrication of 10-Gbps Limiting Amplifier Using an Al–GaAs/GaAs HBT, by Y. S. Kim,* S. J. Kang,* K. Y. Na,* S. H. Park,** T. W. Lee,** M. P. Park,** and K. E. Pyun** (*School of Electrical and Elec. Eng., Chungbuk Nat'l Univ., Cheongju, Korea; **Dept. of Compound Semicon., ETRI, Taejon, Korea): *JKITE,* vol. 34-D, no. 1, pp. 14–22, Jan. 1997.

This paper presents the design, fabrication, and characterization of an AlGaAs/GaAs HBT limiting amplifier for 10-Gbps high-speed optical communication system. The limiting amplifier consists of an input buffer, first-stage amplifier, second-stage amplifier, and output buffer, which results in constant output level for wide input range and low phase deviation between input and output. The modified Cherry Hooper current feedback circuit is used for first- and second-stage amplifiers in order to get good dc linearity and wide bandwidth. The designed limiting amplifier is fabricated using an AlGaAs/GaAs HBT, NiCr resistor, and capacitor. On-wafer measurements of the fabricated limiting amplifier showed about 25-dB S_{21} gain, 12-GHz bandwidth, and eye pattern with good eye opening and about 300 mVpp amplitude.

(14) Design and Fabrication of GaAs HBT IC's for 10-Gb/s Optical Communication System, by S. H. Park,* T. W. Lee,* Y. S. Kim,** H. C. Kie,*** K. M. Song,**** M. P. Park,* and K. E. Pyun* (*Dept. of Compound Semicon., ETRI, Taejon, Korea; **School of Electrical and Elec. Eng. Chungbuk Univ., Cheongju, Korea; ***Dept. of Elec. Eng., Kyungwon Univ., Sungnam., Korea; ****Dept. of Appl. Physics, Kun-kuk Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 3, pp. 152–159, Mar. 1997.

Design and performance of principal four IC's for the 10-Gb/s optical communication system are presented. AlGaAs/GaAs HBT's are basic devices to implement a laser diode driver, a preamplifier, and a limiting amplifier, and GaInP/GaAs HBT's are used for an AGC amplifier. We fabricated 11.5 GHz LD driver, 10.5-GHz preamplifier, 7.2-GHz AGC amplifier, and 10.3-GHz limiting amplifier using the optimized circuit design and the stabilized MMIC's fabrication process.

(15) A New MESFET Channel Current Model including Bias-Dependent Dispersion Effect, by T. M. Roh,* Y. S. Kim,* Y. W. Kim,** W. S. Park,* and B. M. Kim* (*Dept. of Elec. and Electrical Eng. and Microwave Appl. Research Center, Pohang Univ. of Sci. and Tech., Pohang, Korea; **Agency for Defense Development, Taejon, Korea): *JKITE,* vol. 34-D, no. 4, pp. 247–256, Apr. 1997.

A new channel current model of GaAs MESFET suitable for applications to microwave CAD has been developed. The current model includes the bias-dependent frequency dispersion effects and its parameters are extracted from the pulsed I–V measurements at several quiescent bias points. The model is verified by applying to the nonlinear circuit designs of power amplifier and MMIC's mixer.

(16) Design and Characteristics of X-Band Monolithic Series Feedback LNA using 0.5-μm-GaAs MESFET, by Y. J. Jeon, J. M. Kim, and Y. H. Jeong (Dept. of Elec. and Electrical Eng., Pohang Univ. of Sci. and Tech., Pohang, Korea): *JKITE,* vol. 34-D, no. 5, pp. 357–363, May 1997.

A X-band three-stage monolithic LNA (low noise amplifier) with series feedback has been successfully designed and demonstrated by using 0.5-μm GaAs MESFET. In the design of the three-stage LNA, the effects of series feedback to the noise figure, the gain, and the stability have been investigated to find the optimal short stub length. As a result, the inductive series feedback topology which has a 10° short stub in the GaAs MESFET source lead, has been employed in the first stage. The fabricated MMIC LNA's chip size is only 1-mm^2/stage, which is smaller than the previously reported X-band MMIC LNA's. The measured gain is 22.5–23.0 dB in the range of 8–10 GHz with good flatness, and the input/output return losses are less than -10 and -15 dB, respectively. The noise figure (NF) is less than 2.6 dB. The measured data show good agreement with the simulated values.

(17) 10-Gbit/s AlGaAs/GaAs HBT Limiting Amplifier, by B. S. Kwark and M. S. Park (Sec. of Optical Trans., ETRI, Taejon, Korea): *JKITE,* vol. 34-D, no. 7, pp. 521–528, July 1997.

A 10-Gbit/s limiting amplifier IC for optical transmission system was implemented with AlGaAs HBT (heterojunction bipolar transistor) technology. HBT's with 2×10 and 6×20 μm^2 emitter size were used. The HBT structures are based on metal-organic chemical vapor deposition (MOCVD) epitaxy and employ a mesa structure with self-aligned emitter/base and sidewall dielectric passivation. IC was designed to support differential input and output. Small-signal performance of the packaged IC showed 26 dB gain and $f_{3\,\mathrm{dB}}$ of 8 GHz. A single output has 800-mVp-p swing with more than 26-dB dynamic range. The performance of the limiting amplifier was verified through single mode fiber 320-km transmission link test.

(18) The Design of a Microwave Radial Power Combiner, by J. W. Rheem, W. T. Kang, S. H. Lee, and I. S. Chang (Dept. of Elec. Eng., Sogang Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 8, pp. 611–617, Aug. 1997.

In high-power amplifier design, power combiner/divider is used to connect low-power amplifiers in parallel. The radial structure of the power combiner/divider has not only a good characteristics of port-to-port isolation but also an advantage of giving a redundancy to the structure itself by using RF switches. The parastics of power resistor, which would be a problem in design process, are removed by both slot lines and cavity resonators, and the common node in the circuit is redesigned as a planar topology, and thus a new type of 4-way radial power combiner/divider is accomplished at 1840 $\sim$ 1870 MHz PCS frequency band. The insertion loss, reflection, and isolation characteristics of four-way radial

power combiner/divider which can be adaptable to PCS system in this thesis are −0.3, −24, and −27 dB, respectively.

(19) Preparation and Properties of RuO_2 Thin Films by using the RF Magnetron Reactive Sputtering, by S. J. Kang, D. H. Jang, Y. S. Yoon, and D. I. Kim (Dept. of Elec. Eng., Inha Univ., Inchon, Korea): *JKITE,* vol. 34-D, no. 8, pp. 618–624, Aug. 1997.

RuO_2 thin films are prepared by RF magnetron reactive sputtering and their characteristics of crystallization, microstructure, surface roughness, and resistivity are studied with various O_2/(Ar + O_2) ratios and substrate temperatures. As O_2/(Ar + O_2) ratio decreases and substrate temperature increases, the preferred growing plane of RuO_2 thin films are changed from (110) to (101) plane. With increase of the O_2/(Ar + O_2) ratio from 20 to 50%, the surface roughness and the resistivity of RuO_2 thin films increase from 2.38 to 7.81 nm, and from 103.6 to 227 $\mu\Omega$-cm, respectively, but the deposition rate decreases from 47 to 17 nm/min. On the other hand, as the substrate temperature increases from room temperature to 500°C, resistivity decreases from 210.5 to 93.7 $\mu\Omega$-cm. RuO_2 thin film deposited at 300°C shows a excellent surface roughness of 2.38 nm. As the annealing temperature increases in the range between 400–650°C, the resistivity decreases because of the improvement of crystallinity. We find that RuO_2 thin film deposited at 20% of O_2/(Ar + O_2) ratio and 300°C of substrate temperature shows excellent combination of surface smoothness and low resistivity so that it is well qualified for bottom electrodes for ferroelectric thin films.

(20) Design of Reflection Type Low Phase Shift Attenuator, by M. S. Kang, W. T. Kang, and I. S. Chang (Dept. Elec. Eng., Sogang Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 9, pp. 697–702, Sept. 1997.

A transmission-type phase shift attenuator has a poor reflection characteristics at an output port. And that is controlled by the current, its dynamic range decreases due to the current limitation. In this paper, to avoid such disadvantages, a reflection-type low phase shift attenuator has been designed and measured. As a result, at a center frequency (1855 MHz), the reflection-type low phase shift attenuator has an attenuation of 30 dB, within the limit of 3-phase shift and less than −17-dB reflection characteristics at both input and output ports. And it demonstrates the performance of the reflection-type low phase shift attenuator is better than the transmission-type phase shift attenuator with the same measurement specifications.

(21) Frequency Selective Surface with Gridded Square-Loop Elements, by J. H. Ko and M. S. Uhm (ETRI, Taejon, Korea): *JKITE,* vol. 34-D, no. 9, pp. 703–710, Sept. 1997.

A rigorous analysis method of electromagnetic scattering from frequency selective surface with gridded square loop elements in case of oblique incident and arbitrary polarization is presented, which uses the roof-top subdomain basis function. The frequency response and polarization characteristics of the reflected wave and the transmitted wave for various widths of the grid and the conductor square loop, and for the various gaps between the grid and square loop, is investigated. To confirm the validity of presented method, frequency selective surfaces with gridded square loop elements are fabricated with honeycomb structures, calculated values for the frequency response of the reflected wave and the transmitted wave for arbitrary incident angle and polarization are compared with measured values.

(22) A New Lumped Equivalent Circuits for Spiral Inductor with Metal Thickness, by T. Oh and H. S. Kim (Dept. of Telecomm. Eng., Cheju Nat'l Univ., Cheju, Korea): *JKITE,* vol. 34-D, no. 9, pp. 717–723, Sept. 1997.

Square spiral inductors are designed with EM program in accordance with the inner diameter and the metal thickness which is 0.2 and 20 μm, respectively. We propose a parameter extraction method based on the S-parameter. Lumped equivalent circuits of spiral inductors are analyzed with reflection coefficient S_{11}, of which frequency range is $1 \sim 10$ GHz. When metal thickness is 0.2 μm, S_{11} with EM simulation is not the same as S_{11} that of SPICE simulation. So we suggests a new lumped equivalent circuits which compensate circuits. The new lumped equivalent circuits are adequate for other inductor with small scale at high frequencies.

(23) Novel High-Q Vertical Inductor Using Bondwires for MMIC's, by Y. G. Lee, S. K. Yun, and H. Y. Lee (School of Electrical and Elec. Eng., Ajou Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 9, pp. 724–731, Sept. 1997.

A novel high-Q vertical inductor for MMIC's is proposed and characterized in a wide range of frequencies (DC $\sim$ 10 GHz) using the numerical methods such as the PEEC (partial equivalent element circuit), the FDM (finite-difference method), and the MoM (method of moments). Electrical superiority of the vertical inductor to the horizontal is observed in terms of the magnetic flux linkage and the ground screening effect. The vertical bondwire inductor is designed in consideration of the wire bonding feasibility and the optimum electrical performance. This structure is also analyzed using the equivalent circuit and compared with the conventional spiral inductors. From the calculated results, high Q-factors, inductance, and cutoff frequency are observed to be inherent characteristics of the vertical bondwire inductor.

(24) Single-Bias GaAs MMIC Single-Ended Mixer for Cellular Phone Application, by H. I. Kang,* S. E. Lee,* J. E. Oh,* S. G. Oh,** M. H. Kwak,** and D. S. Ma** (*Dept. of Research Center for Elec. Materials and Components Elec. Eng., Hanyang Univ., Seoul, Korea; **Div. of Elec., Kukje Corp., Korea): *JKITE,* vol. 34-D, no. 10, pp. 790–799, Oct. 1997.

An MMIC downconverting mixer for cellular phone application has been successfully developed using an MMIC process including 1-μm ion implanted GaAs MESFET and passive lumped elements consisting of spiral inductor, Si_3N_4 MIM capacitor and NiCr resistor. The configuration of the mixer presented in this paper is single-ended dual-gate FET mixer with common-source self-bias circuits for single power supply operation. The dimension of the fabricated circuit is 1.4×1.03 mm including all input matching circuits and a mixing circuit. The conversion gain and noise figure of the mixer at LO power of 0 dBm are 5.5 and 19 dB, respectively. The two-tone IM3 characteristics are also measured, showing −60 dBc at RF power of −30 dBm. All isolations between each port show better than 20 dB.

(25) Design Method of Stable RF Power Amplifiers Using 3-dB Coupled Line, by S. W. Kim, K. T. Kang, C. G. Kang, and I. S. Chang (Dept. Elec. Eng., Sogang Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 10, pp. 800–807, Oct. 1997.

A new design method of stable RF power amplifier using 3-dB coupled line is proposed in this thesis. The proposed method of broad-band matching consist of resistive matching circuits at low frequency and lossless matching circuits at microwave band. This design method increase the stability of an amplifier and is suitable for interstage matching. When a high-power amplifier is designed using this method for PCS base transceiver station, the measured results shows that the gain of 18.5 dB, and 9 W (39.5 dBm) output power. We use Motorola's MRF6401 for medium power, and MRF6402 for large power and cascaded them.

(26) A 20-GHz Low-Loss Dual-Mode Channel Filter Using Mode Matching Method, by K. W. Chung, J. H. Lee, K. W. Yu, and S. C. Kang (Div. of Satellite Comm., ETRI, Taejon, Korea): *JKITE,* vol. 34-D, no. 10, pp. 829–835, Oct. 1997.

In this paper, we present a 20-GHz low-loss dual-mode channel filter designed by using mode matching method. The performance of dual-mode channel filter mainly depends on iris characteristics. Therefore the exact design of iris is the key point to get good frequency response of the filter. Mode matching technique is widely used to design several kinds of waveguide filters because it is simple in theory and can easily calculate the scattering matrices at the discontinuities with simple structure like iris coupled filters. Additionally the effect for finite thickness of the iris in the dual-mode cavity filter is analyzed by the full-wave method, providing the exact filter implementation without trial and error.

(27) The Fabrication of 2-GHz Circulator Using $Y_3 - 2_xCa_xSn_xFe_{3.5}Al_{1.5}O_{12}$ Garnet, by J. R. Park, T. H. Kim, D. S. Jun, and J. W. Hahn (Sect. of Component Tech. Development, ETRI, Taejon, Korea): *JKITE,* vol. 34-D, no. 12, pp. 984–991, Dec. 1997.

This study was conducted to fabricate 2-GHz circulator using Ca, Sn substituted YIG (yttrium iron garnet) ceramics. When the electric, magnetic and microwave properties were measured in Ca, Sn substituted YIG, the measured permittivity and permeability in microwave frequencies were 16.25, 0.8964. For $Y_{3-2x}Ca_xSn_xFe_{3.5}AI_{1.5}O_{12}$ garnet ceramics sintered at 1400°C, the ferrimagnetic resonance line width (ΔH) at 10 GHz was 53 Oe and saturation magnetization was 375 G. The strip-line circulator was simulated with 3-D FEM (finite-element method) software and designed at the center frequency of 2 GHz. The fabricated strip-line junction circulator using above YIG ceramics had insertion loss of 1.271 dB, return loss of 23.843 dB, and isolation of 21.751 dB at the center frequency 1.855 GHz.

(28) A Study on Parameter Extraction for Equivalent Circuit Model of RF Silicon MOSFET's, by S. H. Lee* and H. K. Yu** (*Dept. of Elec. Eng., Hankuk Univ. of Foreign Studies, Seoul, Korea; **Div. of Semiconductor Tech., ETRI, Taejon, Korea): *JKITE,* vol. 34-D, no. 12, pp. 1024–1031, Dec. 1997.

An accurate extraction technique is developed to determine full equivalent circuit parameters of Si MOSFET's using one set of measured S-parameters without complicated optimization process. This technique is based on the use of analytic Z-parameters expressions for resistances and inductances and the Y-parameter ones for intrinsic parameters. This accuracy is proved over the wide range of gate voltage by observing good agreement between measured and fitted Z-parameter equations and frequency-independent response of the extracted intrinsic parameters. Using this technique, gate voltage-dependencies of model parameters are obtained in the saturation region and these results show the similar behavior to the short-channel effects expected from the device theory.

(29) Low Spurious Drain Mixer for Satellite Transponders, by K. Itoh,* K. Kawakami,* A. Kamikokura,** A. Iida,** O. Ishida,* and S. Betsudan*** (*Information Technology R&D Center, Mitsubishi Electric Corporation, Kamakurashi, 247 Japan; **Kamakura Works, Mitsubishi Electric Corporation, Kamakurashi, 247 Japan; ***Communication Equipment Works, Mitsubishi Electric Corporation, Amagasaki-shi, 661 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 267–278, June 1997.

In the case of single conversion-type transponders used in satellite communications, LO frequency of the mixer is lower than input and output frequencies. In such a frequency relationships, harmonics of LO or higher order mixing products appear as spurious emissions around output frequency. These spurious emissions cannot be suppressed by BPF. This paper presents that a drain mixer is an effective technique to achieve low spurious characteristics in such a frequency relationship. Harmonics of LO current and conductance are indicated by Fourier analysis in cases of SBD and drain mixers. As a result of the analysis, lower spurious level with higher order harmonics are presented in a case of the drain mixer by analytical approaches. Furthermore the same results are also indicated even in Ka-band by measurements and simulations. A developed Ka-band balanced drain mixer has conversion loss of 9 dB with in-band spurious level of -67 dBc.

(30) A Nonlinear GaAs MESFET Drain Current Model for a Microwave Characteristic, by K. Fujii, K. Ogawa, and Y. Takano (Mitaka Plant Site, Japan Radio Co., Ltd., 2075-1-1 Shimorenjaku, Mitaka-shi, 181 Japan): *Trans. IEICE,* vol. J80-C-1, pp. 279–288, June 1997.

This paper describes the importance of the pulse I–V measurement technique to extract drain current equation parameters at microwave operation. This paper verifies that conventional drain current models designed to explain the dc behavior do not agree with the pulsed I–V measurement result. To solve this problem, an improved drain current model which can explain the pulsed I–V characteristic is proposed by the authors. This paper also verifies experimentally that the proposed large-signal model has the capability to explain the pulsed I–V characteristic accurately. Consequently, the pulsed I–V measurement technique and the proposed model can explain very closely to the drain current at the microwave operation. Finally, the proposed model applies to a nonlinear simulation for a MMIC power amplifier, and the simulation

result verifies that this model has excellent capability to simulate nonlinear phenomena of microwave circuits.

(31) The Consideration of Voltage Controlled Charge Sources Controlled by Two Voltage Sources for a GaAs MESFET Large-Signal Model, by K. Fujii, K. Ogawa, and Y. Takano (Japan Radio Co., Ltd., 5-1-1, Mitaka-shi, 181 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 414–422, Sept. 1997.

This paper describes the definition procedure of the voltage dependent charge sources controlled by two voltages for GaAs MESFET large-signal model. There is a well-known problem called the violation of charge conservation between a capacitance in a small-signal model and a charge source in a large-signal model. The violation of charge conservation causes the discrepancy between small-signal equivalent circuit current and large signal equivalent circuit current. To solve the charge conservation problem, the charge source can be compensated by the charge difference which is the same amount of the difference between capacitance current and charge source current. During the derivation procedure the voltage-dependent charge source controlled by two voltages from capacitance, the violation of charge conservation can be solved by introducing the constant of integration. The effect of this theory is verified by the comparison between small signal S parameters and the S parameters calculated from the large signal model. The improved large signal model applies to the real non linear problem solving the MMIC power amplifier. The verification result shows that the improved model is able to calculate accurately the MMIC power amplifier not only fundamental signal behavior but also higher order of harmonics behavior.

(32) Quasi-Transmission-Line Variable Reactance Circuits for a Wide Variable-Phase Range X-Band Monolithic Phase Shifter, by M. Nakatsugawa and M. Muraguchi (NTT Wireless Systems Laboratories, Yokosuka-shi, 239 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 168–173, Jan. 1997.

This paper describes a novel quasi-transmission-line variable-reactance circuit that extends the variable-phase range of phase shifters. It consists of a transmission fine and two shunt varactors. By appropriately choosing the characteristic impedance and electrical length of the transmission line, the variable-phase range can be significantly increased. Since the proposed circuit can be fabricated by the conventional MESFET process, a phase shifter can be integrated with other functional circuits. This enables fully monolithic integration of RF circuits as a one-chip multifunctional MMIC in radio communication systems. The variable-phase range of the prototype X-band monolithic phase shifter is 208°, which is approximately four times as large as that of conventional one.

(33) Low Consumption Power Application of Pulse-Doped GaAs MESFET's, by N. Shiga, K. Otobe, N. Kuwata, K. Matsuzaki, and S. Nakajima (Optoelectronics R&D Laboratories, Sumitomo Electric Industries, Ltd., Yokohama-shi, 244 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 597–603, Apr. 1997.

The application of pulse-doped GaAs MESFET's to a power amplifier module is discussed in this paper. The epitaxial layer structure was redesigned to have a dual pulse-doped structure for power applications, achieving a sufficient gate-drain breakdown voltage with excellent linearity. The measured load-pull characteristics of the redesigned device for the minimum power consumption design was presented. This device was shown to have almost twice the power-added efficiency of a conventional ion-implanted GaAs MESFET. Two kinds of power amplifiers were designed and fabricated, achieving Pout of 28.6 dBm at IM_3 of -40 dBc with Pdc of 8 W and Pout of 33.0 dBm at I IM_3 of -40 dBc with Pdc of 32 W, respectively.

(34) 7-Mask Self-Aligned SiGe Base Bipolar Transistors with f_T of 80 GHz, by T. Tashiro,* T. Hashimoto,* F. Sato,* Y. Hayashi,** and T. Tatsumi** (*ULSI Device Development Laboratories, NEC Corporation, Sagamihara-shi, 229 Japan; **Microelectronics Research Laboratories, NEC Corporation, Tsukuba-shi, 305 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp.707–713, May 1997.

A 7-mask self-aligned SiGe base bipolar transistor has been newly developed. This transistor offers several advancements to a super self-aligned selectively grown SiGe base (SSSB) transistor which has a selectively grown SiGe base layer formed by a cold-wall ultra high vacuum (UHV) / CVD system. The advancements are as follows: 1) a BPSG-filled arbitrary-width trench isolation on a SOI is formed by a high-uniformity CMP with a hydro-chuck for reducing the number of isolation fabrication steps, 2) polysilicon-plug emitter and collector electrodes are made simultaneously using an in-situ phosphorus-doped polysilicon film to decrease the distance between emitter and collector electrodes and also toe reduce the fabrication steps of the electrode, 3) a n^+-buried collector layer is made by a high-energy phosphorus ion-implantation technique to eliminate collector epitaxial growth, and 4) a germanium profile in the neutral base region is optimized to increase the f_T value without increasing leakage current at the base–collector junction. In the developed transistor, a high performance of 80-GHz f_T and mask-steps reduction are simultaneously achieved.

(35) Switched-Capacitor Phase-Shifter Oscillators, by T. Miyazaki,* Y. Horie, * C. Minamitake,* and K. Mizuno** (*Department of Electrical and Electronics Engineering, Kagoshima University, Kagoshima, shi, 890 Japan; **Department of Information Science, Kagoshima University, Kagoshima-shi, 890 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 714–716, May 1997.

A switched-capacitor phase-shifter oscillator of low distortion is discussed. The dc voltage related to the amplitude of oscillation was made for an automatic gain controller. The distortion factor was less than 0.5% in the frequency range from 100 pHz to 1 Hz.

(36) Improved Equivalent Circuit Model of GaAs FET Switch for MMIC Phase Shifter Design, by H. Takasu,* S. Watanabe,* S. Kamihashi*, and M. Ohtomo** (*Microwave Solid-State Department, Komukai Works, Toshiba Corporation, 1 Komukai-Toshiba-cho, Saiwai-ku, Kawasaki-shi, 210 Japan; **Department of Electronics, Tokyo Engineering University, 1404-1, Katakura-cho, Hachioji-shi, 192 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 812–820, June 1997.

An improved equivalent circuit model of a GaAs FET switch for MMIC phase shifters is proposed that incorporates distributed lines into a lumped-constant equivalent circuit

to account for distributed-line effects. The validity of the proposed model is demonstrated by applying a coupled-wave analysis to the FET switch. Comparison of the measured and the simulated phase angles of the S-parameters shows that the improved model gives much better accuracy than the lumped-constant model. X-band 6-bit MMIC phase shifters designed using the improved model are also described.

(37) Dual-Frequency Matching Technique and Its Application to an Octave-Band (30–60 GHz) MMIC Amplifier, by H. Nakajima* and M. Muraguchi** (*NTT System Electronics Laboratories, Atsugi-shi, 243-01 Japan; **NTT Wireless Systems Laboratories Yokosuka-shi, 239 Japan): *IEICE Trans. Electron.*, vol. E80-C, pp. 1614–1621, Dec. 1997.

A single-stage dual-frequency matching network that can simultaneously transform a transistor reflection coefficient to zero at two separate frequencies (a lower frequency f_L and a higher frequency f_H) is proposed. The network is made by adding a shorted stub, the length of which is a quarter-wavelength at f_H, to a conventional L-section matching network composed of a series transmission line and an open stub. The concept of dual-frequency matching is based on the fact that the synthesized shunt admittance of the open and shorted stubs changes from capacitive at f_H to inductive at f_L. By means of the single-stage matching network broad-band amplifier performance, the bandwidth of which is given as $\sim (f_H - f_L)$, can be easily obtained with almost the same design procedures and circuit area used for conventional narrow-band amplifiers. In this paper, the function of the dual-frequency matching network is analyzed in detail and an application of the matching technique to a two-stage amplifier is described. A broad-band performance of $|S_{211}| > 7.4$ dB at 27.0–62.5 GHz has been achieved with a GaAs P-HEMT two-stage MMIC amplifier.

(38) A 40-Gbit/s Decision IC Fabricated with 0.12-μm GaAs MESFET's, by K. Murata,* T. Otsuji,* M. Yoneyama,* and M. Tokumitsu** (*NTT Optical Network Systems Laboratories, Atsugi-shi, 243-01 Japan; **NTT Electronics Technology Corporation, Atsugi-shi, 243-01 Japan): *IEICE Trans. Electron.*, vol. E80-C, pp. 1624–1627, Dec. 1997.

The authors report on a 40-Gbit/s superdynamic decision IC fabricated with 0.12-μm GaAs MESFET's. The key to attaining high-speed decision IC is not only high-speed flip-flop circuits but also wideband input and output buffer circuits. 40-Gbit/s is the fastest operating speed of decision IC's fabricated with GaAs MESFET's.

II. Transmission-Lines and Passive Microwave Devices

(1) Edge-Element Analysis for Periodic Structures, by X.-Q. Sheng and S.-J. Xu (University of Science and Technology of China, Hefei, P.R.C.): *AES*, vol. 25, no.12, pp. 70–73, Dec. 1997.

The periodic structures are analyzed by a method in which the edge-element analysis is combined with the mode-matching method and multimode-network theory. As two examples, the NRD guide periodic structure and the image line periodic structure are calculated with the present method. The numerical results indicate that the present approach can be effectively used in analysis for the periodic structures with higher computation accuracy and efficiency.

(2) Study of RF Field in Complex Cavities with Abrupt Transitions, by S.-W. Yang and H.-F. Li (University of Electronic Science & Technology of China, Chengdu, P.R.C.): *AES*, vol. 25, no. 12, pp. 40–44, Dec. 1997.

Based on modal field expansion techniques, the RF field structures of complex cavity with abrupt transitions in gyrotrons are systematically studied, and the influences of TM-type spurious modes are taken into account. Many factors and changes which affect the resonant frequencies, Q factors, and field profiles are also investigated.

(3) Calculation of Resonant Frequency of Planar Spiral-Strip Resonators, by Z.-F. Jiang (Institute of Electronics, Academia Sinica, Beijing, P.R.C.): *AES*, vol. 25, no. 12, pp. 35–39, Dec. 1997.

A physical model and a method for analyzing and calculating the distributive capacitances and the resonant frequencies of the spiral resonators are described. The equivalent inductances of spiral resonators are evaluated according to Grover's formula, and the calculated results agree well with the experimental data.

(4) Utilization of Wavelet Series in the Propagation and Reflection of a Monopulse in a Layered Nonuniform Medium on a Finite Interval, by Y.-Z. Wang* and W.-B. Wang** (*Northwestern Polytechnical University, Xi'an, P.R.C.; **Xi'an Jiaotong University, Xi'an, P.R.C.): *AES*, vol. 25, no. 9, pp. 33–36, Sept. 1997.

A new wavelet method is represented to analyze the propagation and reflection of a monopulse in a layered nonuniform medium on a finite interval. As an example wavelet solution is compared with Fourier solution when the medium is uniform and at is found that these two solutions from different methods are the same. More importantly, wavelet method can resolve nonuniform medium while Fourier method cannot.

(5) The Wavelet-Based Multigrid Method, by Y.-M. Song and D.-G. Fang (Millimeter Wave Technique Lab., Nanjing University of Science & Technology, Nanjing, P.R.C.): *AES*, vol. 25, no. 9, pp. 29–32, Sept. 1997.

The wavelet-based multigrid method is presented on the comparative study between the multiresolution analysis of wavelet theory and multigrid method. The scaling spaces in wavelet theory serve as the grids in the multigrid method. The wavelet transfers the information between two grids. The numerical results show that the novel method is convergent faster and more accurate than the conventional one. Due to the perfect frame of wavelet theory, the coarse grids and transform operators can be constructed automatically.

(6) Investigation of Millmeter-Wave Waveguide Circulator, by D.-G. Zhang,* S.-W. Yang* and E.-K. Rong** (*Advanced Tech. Res. Center, Shenzhen University, Shenzhen, P.R.C.; **City University of Hong Kong, Hong Kong, P.R.C.): *AES*, vol. 25, no. 6, pp. 102–104, June 1997.

A new method for analyzing a millimeter H-plane waveguide circulator with a partial height ferrite post is presented. Based on the newly derived formulas, several broad-band MMW waveguide circulators have been investigated, de-

signed, assembled, and tested. Good agreement between the analytically obtained performance and experimental results is observed.

(7) Wave Dispersion Property in Completely Plasma-Filled Waveguide, by D.-J. Zhu and S.-G. Liu (High Energy Electronics Research Institute, University of Electronic Science and Technology of China, Chengdu, P.R.C.): *AES*, vol. 25, no. 6, pp. 34–36, June 1997.

The wave dispersion property in completely plasma-filled waveguide with definite magnetic field is analyzed. A revised dispersion equation is derived and calculated. A new division of wave modes is given. Compared with the old division, this new division is more suitable. Also, from the numerical calculation of the new dispersion equation, some errors in former results are corrected.

(8) Quasi-FEM Analysis of Microwave Transmission Lines with Open Boundary, by X.-Q. Dong and T.-Y. An (Microwave Research Institute, East China Normal University, Shanghai, P.R.C.): *AES*, vol. 25, no. 3, pp. 105–107, Mar. 1997.

An efficient improved finite-element method is presented for electromagnetic Laplace's problems with open boundary. The whole infinite domain is divided into a set of infinite elements instead of ordinary finite elements. A transfer matrix is used to construct an equivalent stiffness matrix to model the open boundary, so calculation error introduced by the truncated boundary or absorbing boundary condition used in conventional FEM can be completely avoided.

(9) Analysis of the Finite Discontinuities with FDTD Method and AR Model, by J.-Y. Zhou, Q.-R. Yang and R.-X. Liu (State Key Millimeter Wave Lab., Southeast University, Nanjing, P.R.C.): *AES*, vol. 25, no. 3, pp. 55–58, Mar. 1997.

The analysis of several typical finline discontinuities with the FDTD is presented. Because of the strong dispersion of the finline, a high-order stable DBC is used to improve the absorbing performance of the truncated boundary. In order to save the calculating time, a shorter data from the FDTD algorithm are used to set up AR model, which is used to predict future FDTD data so that more accurate solution can be obtained.

(10) A Special Mode of Electromagnetic Wave in Magnetized Plasma, by D.-J. Zhu and S.-G. Liu (University of Electronic Sci. and Tech. of China, Chengdu, P.R.C.): *AES*, vol. 25, no. 3, pp. 29–31, Mar. 1997.

In the presence of outer magnetic field, the plasma is an anisotropic isotropic medium. This paper analyzes a special electromagnetic wave. Under this condition, there are two equal eigenvalues. The dispersion equation is concluded and calculated, and some discussions are also given.

(11) MEI Method Solution Based on Total Charge Green's Function for Multiconductor Interconnects Modeling in Very High Speed Integrated Circuits, by Y. Cao, R.-H. Jin, and Z.-F. Li (Shanghai Jiaotong University, Shanghai, P.R.C.): *AES*, vol. 25, no. 2, pp. 67–69, Feb. 1997.

The total charge Green's function can be used in the MEI method taking the place of complete Green's function to get the measuring function and then to determine the measured equation of invariance. The capacitance matrices of several kinds of multiconductor interconnects have been computed with this method.

(12) The 3-D Green's Function for Static-steady Fields in Cylindrical-Layered Inhomogeneous Media, by J. Pan and Z.-P. Nie (University of Electronic Science and Technology of China, Chengdu, P.R.C.): *JCIC*, vol. 18, no. 2, pp. 89–95, Feb. 1997.

The theory and high efficient algorithm is set up to obtain the numerical-mode Green's function for static-steady field problem in arbitrary cylindrical-layered media. The unified formulas for potentials in any inhomogeneous regions are derived. The complete Green's functions are given. The formulation is all in matrix forms and numerical integration can be even avoided for block inhomogeneous structures. The efficiency of computation can be two orders higher than that 2-D finite element method.

(13) The Principle and Design of a Ridge Guide ±45° Broadband Phase Shifter, by W.-D. Yu and R.-R. Zhang (The Communication Research Institute, Shiji-azhuang, P.R.C.): *JCIC*, vol. 18, no. 8, pp. 6–15, Aug. 1997.

A new ±45° ridge guide phase shifter (RGPS) is introduced. The theoretic analysis on this RGPS loaded with irises periodicity is described by use of periodic structure theory, micro-jamming theory and equivalent comparison method for the first time. The experiment shows that the theoretic parameters agree with the measurements on the RGPS.

(14) Study on the Calibration Method of 8 mm Measuring Radiometer, by S.-S. Peng and X.-G. Li (Institute of MMW and Lightwave Technology, Nanjing University of Science and Technology, Nanjing, P.R.C.): *JIMW*, vol. 16, no. 4, pp. 279–284, Aug. 1997.

A new calibration method was presented for an 8-mm measuring radiometer. The error of antenna temperature was analyzed with the present method. As the aperture calibration method, the calibration precision is improved when errors are removed. It is economical and convenient for use.

(15) Passive Millimeter-Wave Imaging Techniques, by H.-L. Wang, X.-G. Li, S.-S. Peng and Y.-D. Wang (Nanjing University of Science and Technology, Nanjing, P.R.C.): *JIMW*, vol. 16, no. 4, pp. 297–302, Aug. 1997.

The state-of-the-art in the field of passive millimeter-wave imaging techniques was described. Theoretical and technical analyses of the advanced focal plane array and interferometry synthesis array imaging systems were highlighted. The conceptual design of a novel digital radiometer system, which employs interferometric synthesis approach in the 8-mm wavelength range was presented.

(16) Creeping Wave in the Material, by X.-L. Wang Y.-C. Feng L.-Y. S and X.-M. Qing (Microwave Test Center, University of Electronic Science and Technology of China, Chengdu, P.R.C.): *JAS*, vol. 15, no. 1, pp. 117–120, Mar. 1997.

A new method for computing propagation constants k_n and amplitudes a_n of creeping wave modes in the lossy material is presented. The method combines eignfunction solutions of creeping wave currents with Prony method and solves the numerical computation of k_n, a_n. For the lossless material, propagation constants obtained by the method are in good agreement with those in the literature.

(17) Electromagnetic Surface TM Waves on the Superlattice, by Q. Wang and Z. Jin (Shanghai University, Shanghai, P.R.C.): *JAS,* vol. 15, no. 2, pp. 127–135, June 1997.

The propagation characteristics of surface electromagnetic TM waves on the superlattice are presented. The analysis shows that the orientation angle θ of the crystal axis of the liquid crystal in superlattice plays an important role in the wave propagation. The necessary conditions for the surface wave existence are: 1) $\theta = 0$ or $\theta = \pi/2$ and 2) the real part of the complex dielectric constant of the cladding material has minus value.

(18) Effective Permittivity of Anisotropic Composite Material of Dense Nonspherical Particles and Conductivity Transition, by Y.-Q. Jin, G. Li, and X.-Z. Huang (Fudan University, Shanghai, P.R.C.): *JAS,* vol. 15, no. 2, pp. 163–168, June 1997.

By using the strong fluctuation theory and introducing an auxiliary permittivity, the effective permittivity can be derived, and is applied to the calculation of effective conductivity of composite material embedded by dense conducting and nonspherical particles. It can be seen that the composite material embedded by dense conducting and nonspherical particles has anisotropic effective conductivity and different conductivity transfer.

(19) Analysis of Millimeter-Wave Multilayer Microstrip Lines with Spectral-Domain Green's Functions, by F. Ling and D.-G. Fang (Nanjing University of Technology, Nanjing, P.R.C.): *JAS,* vol. 15, no. 3, pp. 265–271, Sept. 1997.

This paper presents the general and concise expressions of spectral-domain electric and magnetic Green's functions for multilayer media derived by spectral-domain immitance approach. The Green's functions are applied to millimeter-wave multilayer microstrip lines. The dispersion characteristics and the effects of physical parameters on the effective dielectric constant and characteristic impedance are investigated.

(20) A New Method for Solving Electromagnetic Eigenvalue Problems, by Z.-H. Zhu, W. Hong, and H. Ji (Southeast University, Nanjing, P.R.C.): *JAS,* vol. 15, no. 4, pp. 385–393, Dec. 1997.

By adding a known source function to the right-hand side and giving the unknown eigenvalue a trial value, the homogeneous Helmholtz equation that models the eigenvalue problems is turned into an inhomogeneous Helmholtz equation that models the deterministic problems. This method can solve the nonstandard eigenvalue sparse matrix equation by using the methods for the deterministic sparse matrix equation.

(21) Full Wave Analysis of Simultaneous Switching Noise in High Speed MCM by the Method of Characteristics, by J. Zhang, J.-F. Mao, and Z.-F.Li (Shang-hai Jiaotong University, Shanghai, P.R.C.): *JE,* vol. 19, no. 4, pp. 510–515, July 1997.

A two-dimensional electromagnetic model is used to simulate power/ground plane simultaneous switching noise in multichip module. A novel numerical method for the time-domain electromagnetic problems is presented and used to solve the problem. The results obtained are in accordance with that by the method of FDTD and that reported in the literature.

(22) *X*-Band DRO with Low Phase Noise Operating in High-Order Mode, by X.-L. Liu and Z.-L. Sun (State Key Laboratory of Millimeter Waves, Southeast University, Nanjing, P.R.C.): *JE,* vol. 19, no. 3, pp. 420–423, May 1997.

With higher order mode (TE_{021} mode) of the dielectric resonator (DR), a parallel feedback-type dielectric resonator oscillator (DRO) operating at 10.7 GHz is reported. Because of the high loaded quality factor of DR, the oscillator shows excellent phase noise performance (about -88 dBc/Hz at 20 kHz of offset).

(23) The Simulation for Microwave Plasma Breakdown Process, by D.-J. Zhu and S.-G. Liu (Inst. of High Energy Electronics, UEST of China, Chengdu, P.R.C.): *JE,* vol. 19, no. 2, pp. 258–262, Mar. 1997.

Using the fluid model and making the plasma as isotropic medium, the microwave field in a cylindrical cavity is obtained. Coupled with fluid equations for the electron and ion motion, the microwave discharge courses are calculated. The results show that the density distribution of ion and electron is similar to electric field distribution. Also, a critical electron density is exist. Above this density, microwave field will damp rapidly, so the gas ionization is mainly on the surface.

(24) Measurement of Dielectric Constant in the Millimeter-Wave-Band, by B.-Y. Zhang (Beijing University of Posts and Telecommunications, Beijing, P.R.C.): *JE,* vol. 19, no. 2, pp. 286–288, Mar. 1997.

This paper gives the calculating and testing method for the parameters of materials of low loss and high dielectric constant in the millimeter-wave-band. The measuring principle and the testing system are introduced. The measuring results are given. This method is precise, practical, and convenient.

(25) Transient Sensitivity Analysis of Transmission Lines in High-Speed VLSI Circuits, by J.-F. Mao and Z.-F. Li (Shanghai Jiaotong University, Shanghai, P.R.C.): *JE,* vol. 19, no. 1, pp. 72–76, Jan. 1997.

The characteristics method is introduced to analyze the transient sensitivity of transmission lines in high-speed VLSI circuits with respect to the transmission line parameters or terminal parameters, supplying a useful tool for the optimization design of interconnects in VLSI circuits. The characteristics method differs from the existing sensitivity analysis method based on the Numerical Inverse Laplace Transform technique mainly in that the characteristics method can deal with nonlinear terminals and arbitrary transmitted signals.

(26) Analysis of Open Microstrip Structure by Using Diakoptic Method of Lines Combined with Periodic Boundary Conditions, by H.-Q. Zhu, D.-G. Fang, and Y. Long (Nanjing University of Science and Technology, Nanjing, P.R.C.): *JE,* vol. 19, no. 1, pp. 83–89, Jan. 1997.

This paper presents the analysis of open microstrip structure by using diakoptic method of lines combined with periodic boundary conditions (PBC). The parameters of microstrip patch are obtained from patch current excited by plane wave. Impedance matrix elements are computed by fast Fourier transform (FFT), and a reduced equation is solved by diakoptic technique. Consequently, the computing time is reduced significantly. The numerical results obtained are in good agreement with those published.

(27) The Combined Effects of Gyrotropy and Chirality in Circular Faraday Chirowaveguides, by W.-Y. Yin* and M.-Y. Feng** (*Northwestern Polytechnical University, Xi'an, P.R.C.; **Nanjing Shipping Institute, Nanjing, P.R.C.): *JE,* vol. 19, no. 1, pp. 90–96, Jan. 1997.

Based on the method of separating variables and Miller's calculating roots, the propagation characteristics of hybrid modes in homogeneous circular Faraday chirowaveguides are examined in detail. Numerical results are presented to demonstrate the effects of different constitutional parameters on the mode bifurcation, symmetry and nonreciprocity, backward-wave, and attenuation of hybrid modes, which are different from the cases of ordinary gyrotropic and reciprocal chiral waveguides.

(28) A High Accuracy Stable Dispersive Boundary Condition, by J.-Y. Zhou and Q.-R. Yang (State Key Millimeter Wave Lab., Southeast University, Nanjing, P.R.C.): *JE,* vol. 19, no. 1, pp. 137–140, Jan. 1997.

A high-accuracy stable dispersive boundary condition (DBC) is presented, which can be used to model wave propagation in transmission lines by the FDTD. The differential factor in the boundary condition is replaced by a new two-order difference scheme. The new DBC has the same absolute stability as that proposed by the other's, but it has a much better absorbing performance.

(29) Free-Space Scalar Measurement for the Complex Permittivity and Permeability of Lossy Materials, by C.-Q. Zhao and S.-Z. Li (Beijing Institute of Technology, Beijing, P.R.C.): *JM,* vol. 13, no. 1. pp. 26–32, Mar. 1997.

A scalar measurement system using free-space method is introduced. Errors due to multiple reflections between antennas through the surface of the sample are corrected by using frequency-domain data-smooth technique. For obtaining the permittivity and permeability of lossy materials from the amplitude of transmission coefficient, Monte Carlo's method is used to enhance the efficiency of initial point selecting. BFGS optimization method is used to get ϵ_r, μ_r.

(30) An Improved $2\frac{1}{2}$ Dimensional FDTD Method-Algorithm and Applications, by A.-Y. Qing,* W.-H. Yu,** Z.-J. Mao,** and L. Ren*** (*Institute of Electromagnetic Theory and Microwave Technology, Southeast Jiaotong University, Chengdu, P.R.C.; **Beijing Broadcasting Institute, Beijing, P.R.C.; ***Institute of Electromagnetic Theory and Microwave Technology, Southeast Jiaotong University, Chengdu, P.R.C.): *JM,* vol. 13, no. 1, pp. 65–72, Mar. 1997.

A method called "quasi-uniform domain division $2\frac{1}{2}$ dimensional FDTD Method," which is based on "field refreshment with variable time and space steps" and "domain decomposition" is introduced. Some of its applications are also presented.

(31) Analysis and Design of Microstrip Balun Bipolar PIN Diode Electronic-Controlled Attenuator, by X.-W. Sun, Z.-X. Yao, and H.-S. Li (Xidian University, Xi'an, P.R.C.): *JM,* vol. 13, no. 1, pp. 73–76, Mar. 1997.

A kind of the S-band bipolar attenuator with the microstrip balun is analyzed. It has a reasonable construction, a very large dynamic range, and achieves the bipolar attenuating property. The design method and the experimental results are also given. The experiment shows that the maximum attenuation of this bipolar attenuator is about 35 dB within $2.10 \sim 2.30$ GHz frequency band and control voltage from -5 to 5 V.

(32) Capacitance Extraction of Multilayer and Multiconductor Bends, by H. Ji and W. Hong (State Key Laboratory of Millimeter Waves, Southeast University, Nanjing, P.R.C.): *JM,* vol. 13, no. 2, pp. 126–133, June 1997.

An efficient method to calculate the capacitance of multiple conductors embedded in multilayers named dimension reduction technique (DRT) is presented. When DRT is combined with finite difference method, the quasi-static capacitance matrix of bends embedded in multilayer dielectric media is extracted exactly and effectively. Since the method takes full advantage of the characteristic of the stratified structure in integrated circuit, computing time and memory are saved greatly.

(33) Variable Ferrite Coupler, by H.-W. Huang (Nanjing Research Institute of Electronics Technology, Nanjing, P.R.C.): *JM,* vol. 13, no. 2, pp. 139–145, June 1997.

A new microwave variable coupler is introduced. It is composed of a two-port 3-dB coupled-reflecting device and an inner latching ferrite switch. The structure of the coupler is very simple and reliable.

(34) FDTD Analysis of the Electrical Performance for Interconnection Lines in MCM with Perforated Ground Planes, by J. Zhao and Z.-F. Li (Shanghai, Jiaotong University, Shanghai, P.R.C.): *JM,* vol. 13, no. 3, pp. 183–187, Sept. 1997.

The FDTD approach is demonstrated for analysis of the electrical performance of interconnection lines and the extraction of their equivalent circuit parameters in a multichip module (MCM) with perforated ground planes. The distributed circuit parameters with periodic variance of the interconnection lines can be extracted from the data of FDTD analysis.

(35) A High Speed Semi-Analytic Method for Computing SFL Response in Complex Geometries, by F. Yang and Z.-P. Nie (University of Electronic Science and Technology of China, Chengdu, P.R.C.): *CJRS,* vol. 12, no. 2, pp. 136–141, June 1997.

Potential field Green's function in the complex medium is solved by the efficient numerical mode-matching method, which is combined with surface integral equation method to match the complex excited condition on the spherically focused log (SFL), so that the problem of potential field is resolved satisfactorily in the complex medium. The numerical results show excellent agreement with the reference.

(36) Plasma Waveguide in the Lossy Material, by B.-J. Hu and C.-L. Ruan (Institute of Applied Physics, University of Electronic Science and Technology of China, Chengdu, P.R.C.): *CJRS,* vol. 12, no. 4, pp. 375–379, Dec. 1997.

The normal modes in the plasma waveguide in lossy are analyzed, particularly for the variations of their propagation properties with plasma parameters and surrounding material. The characteristic equations of these modes are derived, and their relevant approximate solutions are given. The analysis shows that the propagation properties of such a plasma waveguide can be controlled by choosing proper plasma frequency.

(37) The Use of a Modified Geometric Optics Method in Stratified Media, by X.-P. Wu (Beijing University of Posts

and Telecommunications, P.O. Box 112, Beijing, P.R.C.): *CJRS*, vol. 12, no. 4, pp. 391–395, Dec. 1997.

An accurate analytical expression for reflection and transmission coefficients for a stratified media model is derived for the first time using a modified geometric optics method when the incident radiowave frequency equals to the critical frequency of the media. The media model includes parabolic, linear, and wedge-like models. Some discussions about the result were given.

(38) Reduction of the Bondwire Parasitic Effect using Dielectric Materials for Microwave Device Packaging, by S. J. Kim, S. K. Yun, and H. Y. Lee (School of Electrical and Elec. Eng., Ajou Univ., Seoul, Korea): *JKITE*, vol. 34-D, no. 2, pp. 55–63, Feb. 1997.

For the reduction of parasitic inductance and matching of bonding wire in the package of microwave devices, we propose multiple bonding wires buried in a dielectric material of FR-4 composite. This structure is analyzed using the method of moments (MoM) and compared with the common bondwires and ribbon interconnections. The FR-4 composite is modelled by the Cole-Cole model which can consider the loss and the variation of the permittivity in a frequency. At 20 GHz, the parasitic reactance is reduced by 90, 80, 60% compared to those of a single bonding wire in air, double bonding wires in air and ribbon interconnection in air, respectively. Also, the new bondwire shows very good matching of 60-Ω characteristic impedance and has 15-, 10-, and 5-dB improvement of the return loss and 2.5-, 0.7-, and 0.2-dB improvement of the insertion loss compared to the common interconnections. This technique can minimize the parasitic effect of bondwires in microwave device packaging.

(39) Parasitics Analysis of a Grounded Bondwire for Low-Cost Plastic Packaging of Microwave Devices, by S. K. Yun and H. Y. Lee (School of Electrical and Elec. Eng., Ajou Univ., Seoul, Korea): *JKITE*, vol. 34-D, no. 2, pp. 75–80, Feb. 1997.

The dielectric effects on the parasitics of bondwires buried in slightly lossy dielectric materials have been investigated over a wide frequency range using the method of moments with incorporation of ohmic and dielectric losses. The FR-4 composite is widely used as a basis material for PCB and plastic packages, because of its inherent electrical and chemical stability and low cost. The Cole-Cole model, which is a representative complex permittivity model of epoxy polymers, has been applied to consider the dielectric effects in the MoM calculation. The parasitic impedance of a grounded bondwire in FR-4 composite is greatly increased due to the dielectric loading effect enhanced by the radiation at high frequencies. These calculation results will be helpful for designing and packaging of high-frequency low-cost IC's.

(40) Crosstalk Among Three Microstrip Transmission Lines, by J. Y. Choi* and S. S. Lee** (*Dept. of Info. and Comm. Eng. Namseoul Univ., Seoul, Korea; **Dept. of Elec. Eng. Hanyang Univ., Seoul, Korea): *JKITE*, vol. 34-D, no. 5, pp. 364–371, May 1997.

The Crosstalk among three identical uniform coupled microstrip transmission lines is examined. To analyze the crosstalk, the simultaneous equations for the voltage and current waves on each transmission line are induced from the transmission line equation. The capacitance and the inductance of the line to solve the transmission line equation are calculated by the spectral domain analysis and the space domain analysis. There are three quasi-TEM modes in three microstrip transmission lines and the characteristic mode impedances in each mode are almost equal at a weak coupling state. The crosstalk among three identical microstrip transmission lines is calculated varying the frequency from 50 MHz to 3 GHz.

(41) Boundary Element Characterization of Coplanar Waveguide Discontinuities by Quasi-Static Approximation, by Y. D. Kang and T. K. Lee (Dept. of Avionics, Hankuk Aviation Univ., Goyang, Korea): *JKITE*, vol. 34-D, no. 6, pp. 425–434, June 1997.

By using the boundary element method, the characterization and the circuit modelling of the coplanar waveguide (CPW) discontinuities are performed via quasi-static approximation. The capacitive equivalent circuits are obtained by developing the 3-D boundary element method with collocation method. On the triangular patch, the numerical scheme employed the linear basis functions and the analytic solutions of the integrals on the singular points. The capacitive discontinuities of gaps, end-gaps, and open-ends are characterized and the results compared with the conductor backed coplanar waveguides.

(42) Analysis of Equivalent Inductance in the Coplanar Waveguide Discontinuities by Boundary Element Method, by Y. D. Kang and T. K. Lee (Dept. of Avionics, Hankuk Aviation Univ., Goyang, Korea): *JKITE*, vol. 34-D, no. 6, pp. 435–443, June 1997.

For the circuit modelling of the coplanar waveguide (CPW) discontinuities, the equivalent inductance is analyzed via the three-dimensional boundary element method. The proposed method utilizes the magnetic scalax potential to obtain the magnetic flux passing through the air-dielectric interfaces of the coplanar waveguide. The boundary integral is simplified by use of the symmetry when the substrate is composed of the nonmagnetic material. In the numerical analysis, linear basis function and the collocation scheme are employed. The short-end and the step discontinuities are characterized through the calculations of the equivalent inductance and the capacitance. The present method avoids the usual vector formulation and is quite advantageous in the quasi-static characterization of the CPW discontinuities.

(43) The Design of Transmitting Antenna on the Optical Satellite Communication Up-Link in Rain, by J. H. Jung (Dept. of Electrical, Electronics, and Control and Instrument Eng., Hoseo Univ., Chungnam, Korea): *JKITE*, vol. 34-D, no. 6, pp. 499–506, June 1997.

Today's wireless communication needs the super-high speed for picture transmission as well as voice. The optical communication with the very wide bandwidth is suitable for this demand. To fulfill the optical wireless communication, however, the atmospheric attenuation in rainy weather condition must be overcome. In the optical satellite up-link communication between geosatellite and earth station, the factors of attenuation are turbulence, pointing error, scattering, and so on. The most serious factor of these is the scattering by rain. Under the weather condition of rain and cloud,

in this paper, the atmospheric attenuation which affects the optical satellite up-link communication was considered, and the optimum diameter of the optical satellite transmitting antenna in the earth station versus elevation angles, data rates and rainfall rates was presented.

(44) Input Impedance Analysis of the Coaxial to W/G type Devices, P. H. Lee,* C. Y. Cheon,** and P. S. Shin*** (*Dept. Daewoo Telecom Switching Eng., Seoul, Korea; **Dept. Seoul City Univ. Elec. Eng., Seoul, Korea; ***Dept. Hongik Univ. Elec. Eng., Seoul, Korea): *MITE,* vol. 34-D, no. 11, pp. 879–889, Nov. 1997.

By noticing that most waveguide devices were connected to power source through coaxial line, three dimensional finite element analysis using TEM mode incident was tried. When TEM mode was used, being dissimilar to TE_{10} mode incident, analysis model of TEM mode incident has almost the same geometry with real products. Therefore, the degree of trust about analysis result is improved. Reflection coefficients of coaxial line, W/G adaptor, magnetron obtained by simulation was compared with experimental results.

(45) Design of Direct Coupled Combline Filter with Tapped Line In/Output for *Ku*-Band Satellite Transponder Downconverter, I. B. Yom, K. W. Chung, K. R. Park, and J. M. Kim (ETRI, Taejon, Korea): *MITE,* vol. 34-D, no. 12, pp. 992–1000, Dec. 1997.

The design procedure for direct coupled combline filter with tapped line in/output was summarized on Ku-band satellite frequency downconverter for satellite application. We calculated the resonator dimensions, spacing between successive resonators, ground plane spacing and tapping position of in/output lines in accordance with the given procedure. Partitions were employed between adjacent resonators by inserting irises to improve filter response characteristics. The designed filter was manufactured with Aluminum alloy package to reduce mass, and resonators were machined from the filter body and in/output lines were fixed on resonators with epoxy to survive in vibration condition during launch.

(46) An Efficient Calculation of Interconnect Capacitance and Characteristic Impedance for Coupled Pairs of Microstrip-Like Transmission Lines, by H. Nishiyama* and J. Nakazoe** (*Department of Measurement and Information, Fuji Technical Research Center Inc., Matsushita-Building 8F, 2-12-11 Shibuya, Shibuya-ku, Tokyo, 150 Japan; **Department of Electronic and Communication Engineering, Musashi Institute of Technology, 1-28-1 Tamazutsumi, Setagaya-ku, Tokyo, 158 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 1–10, Jan. 1997.

In this paper the interconnect capacitance between two strip-conductors is computed by the boundary element method (BFN) with the extrapolation method, and a simple expression of the interconnect capacitance for the reciprocal location of strip-conductors is presented. Using the electric image and the principle of superposition in conductors system, a more efficient calculation method of the equivalent capacitance and the characteristic impedance for the coupled pairs of microstrip-like transmission lines in the quasi-TEM regime is presented.

(47) Design of Mitered H-Plane Bends in Rectangular Waveguides by Combining Mode-Matching Method and Port Reflection Coefficient Method, by M. A. Zhewang, T. Yamane, and E. Yamashita (Department of Electronic Engineering, University of Electro-Communications, 1-5-1 Chofugaoka, Chofu-shi, 182 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 78–85, Feb. 1997.

The characterization of mitered H-plane bends in rectangular waveguides is implemented by combining the mode-matching method and the port reflection coefficient method. By approximating the mitered part of the bend with staircases, and employing the port reflection coefficient method, the structure to be analyzed is simplified to waveguide cascaded step junctions. Therefore, the desired scattering characteristics of the mitered bend are conveniently obtained by solving waveguide step junctions using mode-matching method. Variations of numerical results with the number of modal terms and staircases are observed. Special consideration is given to the influence of the mitered part of the bend on the scattering parameters, and discussions of optimal design for realizing minimum reflection are provided.

(48) A Probe Excitation for Dielectric Image Line, by T. Kikuma, N. Ishii, and K. Itoh (Faculty of Engineering, Hokkaido University, Sapporo-shi, 060 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 88–89, Feb. 1997.

In this letter, we propose a novel transition for coaxial probe-to-dielectric image line. Experiments show good results that the return loss is more than 10 dB and the insertion loss is about 0.5 dB for the transition in the operating frequency range 13.5–15 GHz.

(49) The Performance of PML Absorber for Quasi-TEM Wave Propagation Along the Microstrip Line, by T. Namiki (Fujitsu Limited, 9-3, Nakase 1-chome, Mihama-ku, Chiba-shi, 261 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 96–99, Feb. 1997.

This paper presents the performance of Berenger's PML and Chen's modified PML absorbing boundary condition for modeling wave propagation by finite difference time-domain method. Numerical tests are provided for quasi-TEM wave propagating along the microstrip line. Four-cell Chen's Modified PML can enough absorb evanescent wave in the cross section of a microstrip. The reflection of propagating wave from 32-cell Berenger's PML combined with Chen's modified PML placed at the end of microstrip is $-$60–70 dB.

(50) Finite-Element Analysis of Finlines with Magnetized Lossy Ferrites, by K. Hirayama,* S. Takimoto,* Y. Hayashi,* and M. Koshiba** (*Kitami Institute of Technology, Kitami-shi, 090 Japan; **Faculty of Engineering, Hokkaido University, Sapporo-shi, 060 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 109–118, Mar. 1997.

An approach based on the finite-element method is proposed for the analysis of a finline containing a magnetized lossy ferrite. A rectangular edge element is used here, and no spurious solutions appear. The finite-element matrices are reconstructed to be able to calculate the propagation constant directly. Due to the reconstruction, although the sparsity of the matrix in the eigenvalue equation is lost, the propagation constants for both the forward and backward propagation may

be obtained after the eigenvalue equation is solved once. After checking the validity of this approach, finlines containing a magnetized lossy ferrite are analyzed and their propagation characteristics are discussed.

(51) Analysis of Circular-to-Rectangular Waveguide T-Junction Using Mode-Matching Technique, by N. Yoneda,* M. Miyazaki,* T. Nishino,* H. Asao,* H. Nakaguro,** and S. Betsudan*** (*Mitsubishi Electric Corp. Information Technology, R&D Center, Kamakura-shi, 247 Japan; **Mitsubishi Electric Corp. Kamakura Works., Kamakura-shi, 247 Japan; ***Mitsubishi Electric Corp. Communications Equipment Works., Amagasaki-shi, 661 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 119–127, Mar. 1997.

In this paper, a modal scattering matrix of the circular-to-rectangular waveguide T-junction is derived by the mode-matching technique. TE and TM mode of the parallel-plate radial waveguide are applied for the field expansion in the branching region. Using an approximate boundary condition at the interface between the branching region and the rectangular waveguide, the closed-form scattering matrix of T-junction is obtained. The resulting characteristics of the scattering matrix agree well with the calculated results by the 3-D finite element method and the experimental results.

(52) A Novel Trap Mechanism in Coaxial-Coupled Waveguide Filters, by M. Tsuji, T. Yamato, T. Mizuno, and H. Shigesawa (Faculty of Engineering, Doshisha University, Kyotanabe, Kyoto-fu, 610-03 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 159–167, Apr. 1997.

We propose here an unprecedentedly new design idea for coaxial-coupled cutoff-waveguide filters. Contrary to the conventional design approach, in which the coax-waveguide transition is utilized only as an impedance-inverter circuit, the proposed idea utilizes the transition as a structure the serves both as the impedance-inverter circuit and as the high-frequency-trap circuit. These new features have been derived theoretically and verified by experiments that we took.

(53) A Synthesis Method of Wide-Band H-Plane Waveguide Components and Its Experiments, by M. Tsuji, M. Shinkawa, and H. Shigesawa (Faculty of Engineering, Doshisha University, Kyotanabe, Kyoto-fu, 610-03 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 168–176, Apr. 1997.

In this paper, we show a new synthesis method for wide-band H-plane rectangular-waveguide components. The key of this method is to synthesize the components by using the finite-element method in which their arbitrary shape is represented by the polar coordinates. The design examples are demonstrated for both the H-plane offset junction and T-junction, and the experiments that we took prove the effectiveness of out method.

(54) Microstrip, Power Combiner Configuration with Neutralization Capacitors for Compensating Inductive Parasitics, by S. Watanabe and S. Arai (Komukai Works, Toshiba Corporation, Kawasaki-shi, 210 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 244–245, May 1997.

An improved power combiner configuration is proposed. To design high power amplifiers, Wilkinson-type power combiner configurations are often employed. To improve isolation and VSWR of combiner ports, neutralization capacitors are connected in series to an isolation resistor for compensating parasitic effect. In this paper, we describe the design and performance of the proposed power combiner configuration.

(55) Fabrication of CATV Broadband Splitter, by T. Kanie and T. Takeo (*Department of Electronic Engineering, Sendai Polytechnic College, Sendai-shi, 895-02 Japan; **Department of Electronics, Nagoya Municipal Industrial Research Institute, Nagoya-shi, 456 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 250–251, May 1997.

A new type of broadband splitter for CATV networks is proposed. The splitter is composed of one distribution and two impedance matching transformers. These transformers are mounted lengthwise on a substrate with their windings parallel and close to the grounded surface. According to this configuration, the increase in the distributed inductance with a RF frequency is advantageously suppressed. The distribution loss and isolation were measured for the fabricated splitter to be 3.6–4.6 dB and more than 20 dB, respectively, in the frequency range of 20–2400 MHz. The measured return loss was more than 10 and 15 dB in the frequency range of 20–50 MHz and 50–2400 MHz, respectively.

(56) Power Durability of Al–Ta Alloy Film Electrodes Using in Surface Acoustic Wave Filters, by N. Kimura, M. Nakano, and K. Sato (Advanced Products Development Center, TDK Corporation, Ichikawa-shi, 272 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 484–485, Oct. 1997.

In SAW (surface acoustic wave) filters used in RF circuits, a power durability of Al–Ta alloy film electrodes was evaluated. By SEM (scanning electron microscope) observations on the electrode surface after the power durability test, whiskers were observed instead of voids hillocks when Ta content increases.

(57) An Asymmetrical Suspended Stripline Directional Coupler, by M. Miyazaki,* Y. Isota,* N. Takeuchi,** and O. Ishida* (*Mitsubishi Electric Corporation, Information Technology R&D Center, Electro-optics and Microwave Systems Laboratory, Kamakura-shi, 247 Japan; **Mitsubishi Electric Corporation, Communication Equipment Works, Amagasaki-shi, 661 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 553–557 Dec. 1997.

A novel coupled-transmission-line directional coupler is developed using an asymmetrical suspended stripline with unequal conducting strips on both sides of a dielectric substrate. A design method and analysis results are described. The directional coupler has a range of coupling values from -5 to -9 dB which is difficult to be realized by a conventional symmetrical suspended stripline coupler. This directional coupler is useful to the array antenna feed which consists of the suspended stripline with couplers having various range of coupling values.

(58) A Broadband Directional Coupler Using Dielectric Loaded Slit, by H. Oh-hashi, H. Asao, O. Ishida, and H. Kurebayashi (Mitsubishi Electric Corporation, Kamakura-shi, 247 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 558–567 Dec. 1997.

A slit coupled directional coupler loading a dielectric plate in the slit is proposed. The dielectric plate is employed to improve the directivity degraded by the discontinuities at the

slit ends. It is theoretically and experimentally presented that the effect of even and odd mode phase velocity difference caused by the dielectric plate contributes to the compensation of the directivity degradation due to the discontinuities. The directivity of a fabricated 40-dB coupler is greater than 24 dB over a frequency range of 3-octaves.

(59) Resonance Characteristics of a Coupled Dielectric Resonator which Consists of a Dielectric Disk Resonator and a Ring Resonator, by Q. Han,* Y. Kogami,* Y. Tomabechi,** and K. Matsumura* (*Faculty of Engineering, Utsunomiya University, Utsunomiya-shi, 321 Japan; **Faculty of Education, Utsunomiya University, Utsunomiya-shi, 321 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 327–333, Feb. 1997.

Resonance characteristics of a coupled dielectric resonator which consists of a whispering gallery mode dielectric disk resonator and a ring resonator located eccentrically are analyzed. New analytical results of resonance characteristic based on the distributed coupling phenomena between the disk and the ring are obtained. The resonance performances have also been verified experimentally on X-band model. We have found that free spectral range of the coupled resonator is several times larger than that of the single disk resonator and the single ring resonator, respectively. As a result, the eccentric coupled resonator discussed in this paper can be used as a frequency selective element in millimeter-wave integrated circuits.

(60) Coupled-Mode Analysis of Coupled Multiple Microstrip, Lines, by K. Yasumoto and M. Matsunaga (Department of Computer Science and Communication Engineering, Faculty of Engineering, Kyushu University, Fukuoka-shi, 812-81 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 340–345, Feb. 1997.

This dispersion characteristics of two nonidentical coupled microstrip lines and N identical coupled microstrip lines are analyzed using the coupled-mode theory combined with Galerkin's moment method in spectral domain. In this approach, the solutions to the original coupled microstrips are approximated by a linear combination of eigenmode solutions associated with the isolated single microstrip, and the reciprocity relation is used to derive the coupled-mode equations. The coupling coefficients are given by the simple overlap integrals in spectral domain between the eigenmode fields and currents of the individual microstrips. It is shown that the numerical results are in very good agreement with those obtained by the direct Galerkin's moment method over a broad range of weak to moderately strong coupling.

(61) Complex Permittivity Measurement at Pseudo Microwave Frequency Using a Dielectric-Plate-Loaded Cavity Resonator, by A. Nakayama, A. Fukuura, and M. Nishimura (R&D Center Kagoshima, Kyocera Corporation, Kokubu-shi, 899-43 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 1117–1125, Aug. 1997.

This paper describes a nondestructive measurement method for complex permittivity of dielectric plates at 2 GHz, using a cylindrical cavity resonator. The resonator is divided into two parts at the center. Two dielectric plates are symmetrically loaded around the center of the cavity. These plates have high permittivity of 45. A dielectric plate specimen is clamped with these halves. The values of relative permittivity ε' and loss tangent tan δ of the specimen are obtained from the resonant frequency and unloaded Q-value of TE_{O11} mode. Measured results of various materials are compared with those values obtained at 3 and 10 Ghz by other cavity resonator method. An edge effect is taken into account by a reference method, using measurement data of a sapphire plate. The errors of the present method are smaller than 1% and 2–3 $\times$ 10^{-5} for ε' and tan δ, respectively.

III. Microwave Antennas

(1) Study of Broad-Band Characteristics of Rotationally Symmetric Antennas, by L. Xu,* X.-E. Han,* Q.-Z. Lu,* and W.-B. Wang** (*Xidian University, Xi'an, P.R.C.; **Xi'an Jiaotong University, Xi'an, P.R.C.): *AES,* vol. 25, no. 12, pp. 108–111, Dec. 1997.

By applying the extended moment method, the broad-band characteristics of rotationally symmetric monopoly antennas have been analyzed, and the optimum angle of the cone is obtained. The figures of the low-cut frequency versus height, width, and volume of the antenna are shown, and the effects of height and width on the antenna gain have been discussed. Theoretical calculations and experimental results are compared with excellent agreement.

(2) Finite Difference Time-Domain Approach to the Analysis of Active Antenna, by J.-Z. Zhang, Y.-Y. Wang, and W. Hong (Southeast University, Nanjing, P.R.C.): *AES,* vol. 25, no. 12, pp. 105–107, Dec. 1997.

FDTD method is extended to analyze an active antenna. The procedures which are necessary to produce a stable algorithm are described. Because the large signal characteristic of active devices is introduced into the algorithm, it can calculate the transient electromagnetic field effectively.

(3) Full Wave Spectral Domain Analysis of Microstrip Antennas by Wavelet Expansion Method, by J. Xia* and X.-H. Zhao** (*Beijing Institute of Technology, Beijing, P.R.C.; **Beijing Institute of Technology, Beijing, P.R.C.): *AES,* vol. 25, no. 12, pp. 55–59, Dec. 1997.

A full-wave spectral domain analysis of microstrip antennas by wavelet expansion method is presented. The formulas for the wavelet analysis of moment method for the patch induced current distribution are deduced. A numerical example for a rectangular microstrip patch antenna is provided, and the numerical results are compared with previous data with good agreement.

(4) Mutual Admittance Between Slot Antennas on an Ellipsoid, by C.-Q. Gu and Y.-Z. Shu (Nanjing University of Aero. and Astro., Nanjing, P.R.C.): *AES,* vol. 25, no. 12, pp. 1–4, Dec. 1997.

Based on differential geometry, the mutual admittance between rectangular slot antennas on a general ellipsoid is presented by applying the geodesic constant method and UTD formulas and the numerical results are obtained.

(5) A New Plane Integrated Slot Antenna and Its Applications, by N.-C. Yuan, J.-G. He, J.-X. Yin, Y. Su, K.-C. Liu, and Z.-L. Lu (National University of Defense Technology of China, Changsha, P.R.C.): *AES,* vol. 25, no. 9, pp. 43–46, Sept. 1997.

A novel plane integrated ultra-wide band (UWB) antenna used as the radiation and reception of the short pulse is developed. A new UWB feed structure of the coplanar waveguide to slot line is invented and used in slot antenna initially. The experimental results show the advantage of high fidelity of the waveform, high radiating efficiency, and to high antenna gain compared with some common wide-band antennas.

(6) The Analysis of Linear Array of Inclined Slots Cutting in the Narrow Wall of Waveguide, by W.-D. Hu and Q.-J. Yang (Tsinghua University, Beijing, P.R.C.): *AES*, vol. 25, no. 6, pp. 20–24, June 1997.

The moment method of analysis of coupled inlined slotted array cutting in the narrow wall of waveguide is given. The calculated and measured frequency responses of S matrix of two models are compared, which are made up by identical five elements both of single slots and tightly coupled slot pairs. The calculated and measured directional characteristics of a linear array with 68 elements of single slots are also compared.

(7) A New Method for Designing the Vertical Pattern of Broadcasting Transmission Antenna, by G.-Z. Lu (Beijing Broadcasting Instituting, Beijing, P.R.C.): *AES*, vol. 25, no. 3, pp. 118–120, Mar. 1997.

A new polynominal is presented as a designing formula, which can adjust the pattern through the feeding phase only. Some examples are also given to verify the formula and results show that this method is practical.

(8) Analysis of Waveguide Slot Array Using Active Element Pattern Method, by Z.-J. Liu (Tsinghua University Beijing, P.R.C.): *AES*, vol. 25, no. 3, pp. 98–101, Mar. 1997.

Active element pattern method was modified to analyze waveguide slot array. Then, together with moments method, it was used to analyze a 68-elements array. The theoretical result is close to the experimental one.

(9) The Radiation Characteristics of Rectangular Chirostrip Antenna, by H.-L. Zhao, W. Wan, and W.-Y. Yin (Northwestern Polytechnical University, Xi'an, 710072): *AES*, vol. 25, no. 3, pp. 94–97, Mar. 1997.

The model of a rectangular chirostrip antenna having one-layer cover is presented and the spectral-domain dyadic Green's function expression for such antenna structure is derived by means of the spectral-domain immitance approach. The numerical results are shown to demonstrate the effects of chirality admittance and geometrical size of chiral substrate and the geometrical size of rectangular patch on the resonant frequency and radiation pattern. Some interesting phenomena are found and discussed.

(10) The Gaps Scattering Effect in a Two-Cylindrical Compact Antenna Range, by J.-X. Ge, G.-Y. He, and X.-Z. Jiang (Beijing University of Aeron. and Astron., Beijing, P.R.C.): *AES*, vol. 25, no. 3, pp. 25–28, Mar. 1997.

Using equivalent radiating linear magnetic current method and approximate Resnel's integration method, the gaps scattering effect in a two-cylindrical compact antenna range are analyzed. These results show that the effect for the antenna gaps can be omitted when width of the gaps on the antennas is smaller than 1/10 wavelength of the highest frequency.

(11) The Real Frequency Method of Designing Broadband Antenna Impedance Matching Networks, by Y.-H. Chen, Y. Sun, L.-Y. Xiao, and W.-S. Guo (Xi-than University, Xi'an, P.R.C.): *AES*, vol. 25, no. 3, pp. 19–24, Mar. 1997.

This paper gives the theoretical analysis and experimental study of the real frequency method and the standing wave ratio method. The lumped parameter matching network, designed with the real frequency method can solve the broadband matching problem of shortwave and ultrashort wave communication antennas efficiently.

(12) The Parabolic Torus with Bias Rotating Axis, by R.-R. Zhang, J.-C. Li, Q.-T. Li, and J.-S. Zhang (The 54th Institute of Electronic Industry Ministry, Shijiazhuang, P.R.C.): *AES*, vol. 25, no. 3, pp. 14–18, Mar. 1997.

The calculation formula of aberrations deviation at the aperture has been made out. The concise algebraic equation which reveals the relation between geometrical parameters of reflector and property of antenna has been derived. The method of improving the antenna property by reducing the aberrations deviation has been discussed.

(13) Numerical Evaluation for the Sommerfeld-Type Intergrals of Grounded Doubled-Layer, by H.-J. Yuan and J. Zhang (National University of Defense Science and Technology, Changsha, P.R.C.): *JCIC*, vol. 18, no. 9, pp. 81–85, Sept. 1997.

An efficient numerical evaluation for the grounded double-layer Green's function in terms of sommerfeld-type integrals for a horizontal Hertzian dipole on the superstrate is presented. The integral program has been checked to reduce the case of the free space. The current distribution along the spiral antenna arm is determined via the moment method.

(14) Analysis for Reflection and Radiation Characteristics of Tapered Planar Dielectric Surface-Wave Antenna, by S.-J. Xu and L.-J. Zhang (USTC, Hefei, P.R.C.): *JCIC*, vol. 18, no. 10, pp. 22–25, Oct. 1997.

The reflection and radiation characteristics of tapered planar dielectric surface-wave antenna is analyzed by a method which combines the finite element method with the mode-matching procedure. Unlike the conventional method to treat the radiation as a "source-field" problem, in the present approach, the radiation problem is transferred to the propagation problem of surface-waves and space waves from the viewpoint of scattering, as a result, the analysis procedure is tremendously simplified.

(15) Researches on Aperture Efficiency of Fresnel Zone Plate Antenna and Its Design, by C.-F. Ye* and W.-X. Zhang** (*Shanghai Tiedao University, Shanghai,P.R.C.; **Southeast University, Nanjing, P.R.C.): *JCIC*, vol. 18, no. 4, pp. 90–96, Apr. 1997.

Aperture efficiency of Fresnel zone plate antenna is investigated with the field correlation therorem. Results for the circular open waveguide with the dominant mode axe discussed as an illustrative example. By using Kirchhoff's diffraction theorem, data for engineering design of Fresnel zone plate are given hereafter.

(16) Characteristic Analysis for mm-Wave Diffraction Antenna with Continuous Phase Constructure, by Z.-W. Fan,* Z.-W. Lu,* J.-H. Liao,* J.-R. Zhang,** and F.-Y. Chen*** (*State Key Laboratory of Applied Optics,

Changchun Institute of Optics and Fine Mechanics, Chinese Academy of Science, Changchun, Jilin, P.R.C.; **Changchun Institute of Geography, Chinese Academy of China, Changshun, Jilin, P.R.C.; ***National Defense Science and Industry Commission of China, Beijing, P.R.C.): *JIMW*, vol. 16, no. 4, pp. 311–315, Aug. 1997.

The measurement results for a new type of mm-wave antenna-diffraction antenna were reported. The results show that this kind of antenna possesses good electrical features.

(17) A Simple Method for Calculating Radiation Pattern of the Ring Focus Antenna, by L.-F. Qi and D.-M. Yao (China Defense University of Science and Technology, Changsha, P.R.C.): *JAS*, vol. 15, no. 1, pp. 121–126, Jan. 1997.

The aperture field distribution of the ring focus is reviewed in view of the energy conservation law, and the simple formula for calculating its radiation pattern is deduced. The method has the characteristics of clear concept, simple calculation formula and easy programming. It is suitable for engineering calculation and analysis of the ring focus antenna.

(18) Recursive Algorithm for Adaptive Arrays and Systolic Array Implementation, by X.-C. Chan and M. Leng (Information and Intelligence System Institute, Zhejiang University, Hangzhou, P.R.C.): *JE*, vol. 19, no. 6, pp. 751–755, Nov. 1997.

A new recursive algorithm for adaptive array weight vectors and its systolic array implementing structure are proposed, which are based on the QR factorization algorithms and the idea of the algorithmic engineering. The algorithm can realize fully parallel and pipeline processing.

(19) Analysis of Rectangular Microstrip, Patch Antennas Covered with N-Layer Dielectric, by G. Liu,* C.-F. Ye,** and S.-S. Zhong*** (*Wave Scattering and Remote Sensing Center, Fudan University, Shanghai, P.R.C.; **Shanghai Tiedao University, Shanghai, P.R.C.; ***Shanghai University, Shanghai, P.R.C.): *JE*, vol. 19, no. 4, pp. 527–531, July 1997.

A generalized spectral Green's function formulation of N-layer superstrate structure is given. A full-wave analysis model for rectangular microstrip antennas covered with N-layer dielectric has been established by the spectral Green's function. The unknown surface current density on microstrip patch for such structure is found as the solution of an integral equation. The input VSWR and radiation patterns of antenna are also obtained. The numerical results have been verified by the experimental results.

(20) Average Brightness Temperature of Antenna Aperture, by Z.-Q. Li (Tsinghua University, Beijing, P.R.C.): *JE*, vol. 19, no. 1, pp. 128–131, Jan. 1997.

This paper presents an idea for the average brightness temperature of antenna aperture and its expression for lossless antenna with matched and unmatched noise sources. The expressions shows that the average brightness temperature of antenna relates with three fetors: coefficient of useful area antenna, noise temperature of noise sources and reflective coefficient of noise sources.

(21) Scattering Analysis of Focal Field Distributions for Fresnel Zone Plate Antenna, by C.-F. Ye* and W.-X. Zhang** (*Shanghai Tiedao University, Shanghai, P.R.C.; **Southeast University, Nanjing, P.R.C.): *JE*, vol. 19, no. 1, pp. 132–126, Jan. 1997.

By analyzing the scattered fields from zone plate reflectors, the focal distributions of Fresnel zone plate antenna are investigated in the view of receiving antenna analysis.

(22) A Four Bands Co-body Circular Polarized Microstrip Antenna, by Z.-Q. Zheng and J.-Y. Yin (East China Normal University, Shanghai, P.R.C.): *JM*, vol. 13, no. 2, pp. 146–152, June 1997.

A circular polarized rectangular microstrip antenna of co-body with four bands is designed. Ranging from 800–2500 MHz, each radiation patch is optimized on a 200×180 mm^2 substrate, so that the affection of half-power beamwidths, polarizations and input impedances among four bands is minimized. Test results are: VSWR ≤ 1.3, axis-ratio less than 3 dB. The isolation between patches in each band is more than 25 dB (in general). The gain is approximately equal to 5 dB.

(23) Millimeter Wave Diffraction Antenna, by Z.-W. Fan,* Z.-W. Lu,* J.-H. Liao,* J.-R. Zhang,** and F.-Y. Chen*** (*State Key Laboratory of Applied Optics, Changchun Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, Changchun, P.R.C.; **Changchun Institute of Geography, Chinese Academy of Sciences, Changchun, P.R.C.; ***National Defense Science and Industry Commission of China, Beijing, P.R.C.): *JM*, vol. 13, no. 2, pp. 155–159, June 1997.

The design and manufacture of millimeter-wave diffraction antenna, based on scalar diffraction theory, are described. Recent relevant results are included. Several kinds of transmission and reflection configurations are discussed and reviewed.

(24) A Wideband Impulse Antenna for Transient Electromagnetic Field Measurements, by C. Yu* and H.-M. Guo** (*Shanghai University, Shanghai, P.R.C.; **China Research Institute of Radiowave Propagation, Xinxiang, P.R.C.): *CJRS*, vol. 12, no. 2, pp. 190–194, June 1997.

A design of the wideband impulse antenna for transient field measurements is described and some measured results are presented. The results show that this antenna has the characteristics of both the high waveform fidelity and the wideband. The fabricated antennas have been applied in a transient electromagnetic measurement system.

(25) Focal Field Distribution of Double-Layered FZP Lens, by G.-Z. Jiang and W.-X. Zhang (State Key Lab of Millimeter Waves, Southeast University, Nanjing, P.R.C.): *CJRS*, vol. 12, no. 3, pp. 247–253, Sept. 1997.

Based on the improved full-wave analysis, the field distribution in focal region of a double-layered FZP lens under normal incidence is analyzed, and its calculations are in good agreements with the published experimental results. The field distribution of FZP lens under various circumstances: normal or inclined incidence, single or double layered FZP lens, with or without dielectric substrate.

(26) Circularly Cylindrical Conformal Slotarray, by Q.-J. Yang and G.-X. Fan (Tsinghua University, Beijing, P.R.C.): *CJRS*, vol. 12, no. 4, pp. 347–355, Dec. 1997.

The design principle of the circularly cylindrical conformal slotarray fed by the couplings with the circularly curved waveguide is given. The calculations of coupling slots between

the curved waveguide and the fan shaped straight waveguides are emphasized. The coupling slots control the strengths of excitations of the radiating waveguides and compensate the phase each slot located at the cylindrical surface.

(27) Pattern Synthesis of Circular Array with Coupling, by Z.-J. Zhang and Z.-H. Feng, (State Key Lab. on Microwave and Digital Communications, Tsinghua University, Beijing, P.R.C.): *CJRS,* vol. 12, no. 4, pp. 361–268, Dec. 1997.

A new method, named eign-driven method, with which the circular array can be analyzed, is proposed. The desired array pattern is calculated by vectorial superposition of eign-driven patterns. Coupling between array elements and mismatch at the input port are also considered. For certifying the valid of this method, an 8- and a 16-elements low side-lobe circular array are analyzed.

(28) Radiation of an Electric Dipole Vertical to the Geo-Magnetic Field in an Anisotropic: Ionospheric Plasma, by K. Li,* W.-Y. Pan,* and Y.-R. Miao** (*China Research Institute of Radiowave Propagation, State Key Lab. for Properties and Modelling of Radiowave Environment, Xinxiang, P.R.C.; **Shanghai Astronomical Observatory Environment, Xinxiang, P.R.C.): *CJRS,* vol. 12, no. 4, pp. 385–390, Dec. 1997.

The radiation of an electric dipole vertical to the geomagnetic field in an infinite ionospheric plasma is analyzed. The near field and far field expressions are obtained. The calculation results of the far field, especially to the condition of considering the influences of the collision, are given.

(29) The Calculation of the Pattern of Sleeve Dipole Antenna with Reflective Cavity, by S.-B. Chen, Z. Song, H.-B. Yan, and F.-B. Liu (Electronic Engineering Institute, Hefei, P.R.C.): *CJRS,* vol. 12, no. 4, pp. 401–406, Dec. 1997.

The sleeve dipole antenna with reflective cavity is analyzed. The radiation pattern and some performance parameters are calculated. The theoretical results are basically in accordance with the experimental data.

(30) Study of the Function of Base Station Antennas for Cochannel Interference Reduction in Mobile Telecommunication, by T.-K. Qin (Nanjing University of ports and telecommunications, Nanjing, P.R.C.): *CJRS,* vol. 12, no. 4, pp. 418–422, Dec. 1997.

The principle that a titled base-station antenna of cellular mobile communications is conductive to improve the reduction of cochannel interference between the cells is expounded, and how to adjust the titled angle of the antenna is also discussed for making the antenna more effective in the reduction of cochannel interference.

(31) Characteristics Study of GPS Anti-Interference Adaptive Circular Array, by Z. Wang and S.-J. Huang (University of Electronic Science and Technology of China, Chengdu, P.R.C.): *CJRS,* vol. 12, no. 4, pp. 448–452, Dec. 1997.

The characteristic of power inversion circular array under the condition of strong interference is studied. The results of computing simulation show that the power inversion circular array is adaptable to the case of GPS antiinterference.

(32) Radiation Characteristics of a Slot Antenna in a Conducting Cylinder Covered with a Moving Isotropic Plasma Layer, by N. T. Kim (Dept. of Elec. Eng., Inje Univ., Kimhae, Korea): *JKICS,* vol. 22, no. 2, pp. 298–305, Feb. 1997.

In this paper, the radiation characteristics of a slot antenna in a conducting cylinder covered with a moving isotropic plasma layer are analyzed.

Integral representations of the electromagnetic fields in the spectral domain radiated through the plasma layer are derived and converted into the fields in the spatial domain by saddle-point integration. Radiation null which brings about distortion in the radiation pattern is explained by the zero of integrand in an asymptotic integral as a function of plasma and velocity parameters.

Numerical results for a radiation null calculated from various plasma and velocity parameters correspond to the results of planner structure.

(33) Antenna Factors of Short Dipole Antennas with Roberts Balun, by K. C. Kim (Dept. of Electrical and Elec. Eng., Yeungnam Univ., Taegu, Korea): *JKICS,* vol. 22, no. 3, pp. 532–538, Mar. 1997.

Exactly calculated antenna factors are required for determining EMI levels in an actual radiated emission test. In this paper, the antenna factors of short dipole antennas above the ground plane are calculated theoretically for the antenna with Roberts balun specified ANSI C63.5 regulation. Also treated is a half-wavelength dipole antenna with Roberts balun to compare the antenna factors with those of resonant dipole antenna. In formulation of antenna factors the antenna is treated as the boundary value problem of Maxwells equations and is analyzed by the Galerkins method of moments. The balun is treated using circuit theory based on power transmission mismatch.

(34) A Spatially and Temporally Correlated Fading Channel Model for Smart Antenna Application, by S. T. Kim,* N. I. Yun,* H. W. Jung,** and H. K. Park* (*Radio Comm. Res. Center, Yonsei Univ., Seoul, Korea ; **Wireless Comm. Res. Lab., Korea Telecom., Seoul, Korea): *JKICS,* vol. 22, no. 4, pp. 611–617, Apr. 1997.

In this paper a new fading model is proposed, which is well consistent with the real environment of smart antenna applications since it is spatially and temporally correlated simultaneously. The new model (STCFM: spatially and temporally correlated fading model) is derived statistically in spatio-temporal domain so that it can provide high accuracy in the evaluation of the smart antenna system. As will be seen, the simulation results agree well with the theory.

(35) A Study on the Active Phased Array Antennas with Slotline Coupling, by C. Mun,* S. T. Kim,** Y. J. Yoon,* and H. K. Park* (*Dept. of Radio Eng., Yonsei Univ., Seoul, Korea; **Dept. of Elec. Eng., Yonsei Univ., Seoul, Korea): *JKICS,* vol. 22, no. 5, pp. 981–989, May 1997.

In this paper, the five-element active phased array antennas coupled through slotline between elements are designed and fabricated. A recent studies on the active phased array antennas use the transmission line coupling which can be designed to provide strong coupling and the appropriate coupling phase. But this structure has limitation of expanding in two dimensions for planar active phase array antennas and distortion

of the radiation pattern caused by coupling network. Thus our work proposes the slotline coupling structure as the broadband coupling network for the active phased array antenna. In experiment, five-elements active phased array antennas have steering range from 30 to 20° off broad-side as the free-running frequencies of end elements are controlled. The overall results show that the proposed slotline coupling structure is suited for the coupling network in the active phased array antenna system. And the proposed coupling structure solves the expansion problem and eliminates the distortion of the radiation pattern caused by the spurious radiation of the transmission line coupling network. Thus this can be expanded to two dimensional coupling network for the planar active phased array antenna system.

(36) The Radiation Pattern Calculation of the Electromagnetically Coupled Microstrip, Dipole Array Antenna using the FDTD Method, by Y. S. Son and H. B. Yoon (Dept. Elec. Eng., Dongguk Univ., Seoul, Korea): JKICS, vol. 22, no. 7, pp. 1459–1467, July 1997.

The current on the thin planar structure as an element of the transversely fed electromagnetically coupled (EMC) microstrip dipole array antenna is obtained by using the integral forms of the finite-difference time-domain (FDTD) method. This method was applied to calculating the optimum current distribution (Dolph–Tchebyscheff distribution) of each dipole element on the feed line as a function of their offset positions for the narrow main beam width and the side beam level below −20 dB. The current on each dipole substitutes for the electric and magnetic current densities on the virtual surface of the FDTD calculation to express the far field intensity, the calculation time and the computer memory can be reduced to about 80% and 1.3 Mbyte, respectively.

The calculated radiation patterns are compared to the measured values and these are in good agreement.

(37) A Design and Fabrication of Active Phased Array Antenna for Beam Scanning Using Injection-Locking Coupled Oscillators, by D. H. Lee,* K. H. Kim,** and Y. S. Hong*** (*Korean Industrial Property Office, Seoul, Korea; **Telson Telecom and Tech. Co. Ltd., Seoul, Korea; ***Dept. of Elec. Eng. Ins. of New Tech., Kwangwoon Univ., Seoul, Korea): *JKICS,* vol. 22, no. 8, pp. 1622–1631, Aug. 1997.

A three-stage active microstrip phased array antenna (AMPAA) is implemented using injection-locking coupled oscillators (ILCO). The AMPAA is a beam-scanning active antenna with capability of electrical scanning by frequency variation of ILCO. The synchronization of resonance frequencies in array elements is occurred by ILCO, and the ILCO amplifies the injection signal and functions as a phase shifter. The microstrip patch is operated as a radiation element. The unilateral amplifier is a mutual coupling element of AMPAA, eliminates the reverse locking signal, and controls the locking bandwidth of ILCO. The possibility of monolithic microwave integrated circuits (MMIC) of T/R module is proposed by simplified and integrated fabrication process of AMPAA. The 0.75 λ_0 is fixed for a mutual coupling space to wide the scanning angle and minimize the multimode. The AMPAA has beam scanning angle of 31.4°, HPBW (half power beam widths) of 26°, directive gain of 13.64 dB and side lobe of −16.5 dB were measured, respectively.

(38) Analysis of Microstrip, Antenna with Waveguide Feeding Structure, by S. H. Choi and S. W. Nam (School of Elec. Eng., Seoul Nat'l Univ., Seoul, Korea): *JKICS,* vol. 22, no. 8, pp. 1740–1746, Aug. 1997.

In this paper, a waveguide-fed slot-coupled microstrip antenna is proposed as enhanced feeding structure of microstrip antenna and an analysis is presented. The presence of dielectric substrate between a strip and a slot is explicitly taken into account in this analysis. The evaluation of the antenna characteristics is carried out using the method of moments and the spectral domain approach in terms of the electric current distribution on the strip and the magnetic current distribution on the slot. From the results, we can conclude that the proposed structure is adequate for array antennas, due to ease of mass production and enhanced antenna performance.

(39) Design of the Helical Array Antenna for the Domestic Broadcast Satellite, by S. O. Maeng* and H. K. Choi** (*High Gain Antenna Co. Ltd., Seoul, Korea; **Dept. of Elec. Eng., Dankook Univ., Seoul, Korea): *JKICS,* vol. 22, no. 8, pp. 1747–1754, Aug. 1997.

The helical array antenna is designed for domestic DBS (direct broadcast satellite) reception. The antenna diameter is determined 30 cm with 168 elements to cover from Moojoo (beam center) to Seoul. The helical antenna with two-turns and 4° pitch angle is chosen as array elements for good axial ration and antenna height. In array antenna design, row distance is 0.787λ, array distance is 0.824λ in the same row. The feed is constructed using the radial waveguide to decrease the height of antenna. The measured values of the designed antenna are not only satisfied with the design goals but also similar to theoretical values except the axial ratio.

(40) A Circular Microstrip, Antenna with a Parasitic Element, by I. M. Koo * and S. S. Lee** (*Dept. of Elec. Comm. Eng., Hanyang Univ., Seoul, Korea; **Dept. of Elec. Eng. Hanyang Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 1, pp. 1–7, Jan. 1997.

In this paper, several parasitic elements are added to the circular microstrip antenna in order to increase its bandwidth. Three kinds of parasitic elements such as cone, circular plate, and ring types are applied and input VSWR's, radiation patterns, and input impedances are measured. The optimal sizes of each parasitic element are obtained and the variations of the bandwidth according to the height from the patch are also measured. In the case of the ring type, the optimum bandwidth is obtained at the height of 10 mm from the patch to the parasitic element. In the cases of conical and circular plate types, the maximum bandwidth is obtained at the height of 45 mm from the patch to the parasitic elements.

(41) Approximate Analysis of Rectangular Microstrip Patch Antenna Located in A Rectangular Waveguide, by D. K. Park,* D. S. Lee,** and H. I. Hwang** (*Dept. of Elec. and Telecomm. Eng., Korea Maritime Univ., Pusan, Korea; **Materials and Components Res. Team #2, KETI, Pyungtaek, Korea): *JKITE,* vol. 34-D, no. 12, pp. 978–983, Dec. 1997.

In this paper, the input impedance and efficiency of a rectangular microstrip patch antenna located inside a rect-

angular waveguide is calculated by using the cavity model and the mode excited by the patch antenna which is modeled as an equivalent surface magnetic current on the conducting plate. Measured return losses of a rectangular microstrip patch antenna tuned at 5.93 GHz in the free space and inside the rectangular waveguide are compared and found to be in good agreement with calculated results.

(42) An Omnidirectional Circularly Polarized Slot-Array Antenna on a Coaxial Cylinder with a Shaped Beam in the Vertical Plane, by K. Iigusa, T. Teshirogi, and M. Fujita (Communications Research Laboratory, Ministry of Posts and Telecommunications, Koganei-shi, 184 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 127–130, Jan. 1997.

We propose an antenna made of an array of slot pairs on a coaxial waveguide having a diameter larger than the operating wavelength, fed by a radial waveguide. Omnidirectional characteristics in azimuth and circular polarization are verified by experiments. The feasibility of beam shaping along the cylinder axis is also shown.

(43) Beamspace Adaptive Array Antenna for Broadband Signals, by T. Sekiguchi,*† R. Miura,*†† and Y. Karasawa*† (*ATR Optical and Radio Communications Research Laboratories, 2-2 Hikaridai, Seika-cho, Kyoto-fu, 619-02 Japan; †Presently, ATR Adaptive Communications Research Laboratories; ††Presently, Communications Research Laboratory, Ministry of Posts and Telecommunications): *Trans. IEICE,* vol. J80-B-II, pp. 171–181, Feb. 1997.

In this paper, we propose a beamspace adaptive array antenna for broadband signals. The proposed beamspace adaptive array antenna has a multiple digital beamformer that can pass broadband signals. A few adaptive weights follow a beam selector. The number of the adaptive weights of the proposed adaptive array is considerably less than that of an element space adaptive array with tapped-delay-line circuits. We prove by computer simulation that interference suppression of the proposed beamspace adaptive array is as good as that of the element space adaptive array and that it has the property of much faster convergence.

(44) Cochannel Interference Reduction Method Using CMA Adaptive Array Antenna, by H. Furukawa,* Y. Kamio,** and H. Sasaoka** (*National Police Agency, Tokyo, 100 Japan ; **Communications Research Laboratory, MPT, Koganei-shi, 184 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 292–295, Mar. 1997.

This paper describes a method for reducing the cochannel interference in land mobile communications using the CMA adaptive array antenna. In this method, a replica of the interference signal is generated and then eliminated from the received signal, and thus the desired signal can be obtained. Computer simulation results confirm that the proposed method reduces the cochannel interference effectively.

(45) Characteristics of a Multifrequency Modified Transmission Line Antenna for Mobile Telephone Using Closed-Spaced Parasitic Elements, by Y. Kumon and T. Tsukiji (Faculty of Engineering, The Fukuoka University, Fukuoka-shi, 814-80 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 296–300, Mar. 1997.

We developed a multifrequency modified transmission line antenna (MTLA) for a mobile telephone using closed-spaced parasitic element. Properties of this antenna are analyzed by means of the moment method. It is possible to adjust an operating frequency of this antenna by changing a size of parasitic element easily. Moreover, it is concluded that the MTLA with two parasitic elements becomes the wide-band and multifrequency mobile communication antenna.

(46) Numerical Analysis of an Arbitrary Horizontal Antenna above a Lossy Ground, by Y. Konishi and K. Nakagawa (Department of Electronic Engineering, Aichi College of Technology, Gamagori-shi, 443 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 301–303, Mar. 1997.

The purpose of this paper is to propose a method of numerical analysis of an arbitrary horizontal antenna above a lossy ground. First, the integral equation is derived by using the method of equivalent circuits. It is transformed to Mei's equation easily. Therefore, the point matching method is available. As an example, numerical results are presented for complete S dipole.

(47) Three-Element Fiber-Type Optical Phased Array Antenna Having a Function of High-Speed and Two-Dimensional Optical Beam Steering, by K. Inagaki*† and Y. Karasawa*† (*ATR Optical and Radio Communications Research Laboratories, 2-2 Hikaridai, Seika-cho, Kyoto-fu, 619-02 Japan; †Presently, ATR Adaptive Communications Research Laboratories): *Trans. IEICE,* vol. J80-B-11, pp. 397–405, May 1997.

We propose a new optical phased array antenna which enables high-speed and two-dimensional optical beam steering. It consists of an integrated optical feeding system and two-dimensionally arranged array antenna part, connected by polarization maintaining fibers. Three-element experimental system demonstrates the wide bandwidth from dc to 924 MHz in controlling the phase shifters, and two-dimensional beam steering over 0.2°. Graded index fiber (GIF) lens are used as element antennas to reduce grating lobes, and theoretical study shows a grating lobe level of −14.5 dB and a gain factor of 0.815 is achievable.

(48) Design and Analysis of Small Multisector Antenna for Wireless LAN's Made by Monopole Yagi-Uda Array Antenna, by T. Maruyama, K. Uehara, and K. Kagoshima (NTT Wireless Systems Laboratories, 1-2356 Take, Yokosuka-shi, 238-03 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 424–433, May 1997.

This paper proposes a new small multisector antenna for wireless LANS. It consists of multiple monopole Yagi-Uda arrays arrayed on a circular, finite ground plane. In the multisector monopole Yagi-Uda array (MS-MPYA), an array setting effect is observed in the horizontal radiation pattern. Numerical analysis and experimental results clarify that setting metallic fins between each array is useful in eliminating the main beam division effect which would otherwise occur due to strong coupling between arrays. When the metallic fins are used, the beam width is reduced 10° in the horizontal plane due to mutual sector interaction. Antenna characteristics are decided by array length, ground plane length, reflector height, and fin length. We establish the MS-MPYA design method.

We clarify that the MS-MPYA has a lower profile than corner reflector or horn antennas.

(49) A Study on Planar Loop Antenna, by M. Muramoto,* N. Ishii,* K. Itoh,* and K. Sasaki** (*Hokkaido Univ., Nishi 8, Kita 13, Kitaku, Sapporo-shi, 060 Japan; **Sendai Lab., Kokusai Electric Co. Ltd., 3-14, Akedori, Izumi-ku, Sendai-shi, 981-32 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 434–439, May 1997.

The characteristic of a planar loop antenna for portable radios are presented. This antenna consists of two planar conductive boards which are placed in parallel at a spaced interval and short conductors. In this paper, we proposed a planar loop antenna with two short positions which can be switched. If the positions are switched at will, it is possible to provide the more desirable condition responsive to the direction of the radio waves. And we performed a fundamental experiment in order to investigate the validity of our proposal.

(50) Proposal and Analysis of Ultra-Large Aperture Array Antennas, by Y. Murao* and T. Takano** (*Division of Engineering, Graduate School, University of Tokyo, Bunkyo-ku, Tokyo, 113 Japan; **The Institute of Space and Astronautical Science, Sagamihara-shi, 229 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 501–506, June 1997.

Antennas larger than 100 m in diameter have been discussed for satellite communications and solar power satellites. This paper proposes antennas with the diameter of 100 m comprising circular and hexagonal apertures of approximately 10 m in diameter. Numerical analysis shows that the antenna gain is approximately 65 dBi and the half power beamwidth is 0.08°, when the amplitude and the phase of the field on the element aperture are constant. Grating lobes caused by arraying the apertures are smaller than the first sidelobe with large apertures. More than 80% of the total radiated power can be inside the first zeros of the radiation pattern. The main beam is steered by 0.1° by phased array with the penalties of 0.2 dB gain decrease and 6% power loss.

(51) A Land-Mobile Satellite Tracking Experiment with a DBF Self-Beam Steering Array Antenna, by R. Miura*†1 and T. Tanaka*†2, A. Horie*†3, T. Sekiguchi† 4, T. Inoue*†4, Y. Karasawa*†4, and H. Inomata*†5 (*ATR Optical and Radio Communications Research Laboratories, 2-2 Hikaridai, Seika-cho, Kyoto-fu, 619-02 Japan); (†1 Presently, the Communications Research Laboratory, MPT); (†2 Presently, the Hewlett-Packard Japan Ltd.,); (†3 Presently, the Furuno Electric Co. Ltd.,); (†4 Presently, ATR Adaptive Communications Research Laboratories); (†5 Presently, the Association of Radio Industries and Businesses); *Trans. IEICE,* vol. J80-B-II, pp. 547–557, July 1997.

This paper discusses a land-mobile satellite experiment with a digital beamforming self-beam steering array antenna, which allows automatic and open-loop beam steering toward the unknown direction of a signal arrival. Beam-space maximal-ratio combination was implemented as the steering algorithm on a single-board DSP which consists of the field-programmable gate arrays. We received a signal in 1.5-GHz band from the Japanese ETS-V satellite. Through the experiment, we demonstrated fast beam steering and stable tracking under real mobile conditions. Moreover, the steering to the direct signal arrival was not affected even with the arrival of a strong, reflected multipath signal, and a possibility of optimal combination of multipath signals was demonstrated by multidirectional beam steering patterns.

(52) Beamformer with a Single Set of Variable Phase Shifters for the Pointing Control of Multibeam Satellite Antenna, by Y. Matsumoto, Y. Hashimoto, T. Ide, M. Sakasai, N. Hamamoto, and M. Tanaka (Communication Research Laboratory, MPT, Koganei-shi, 184 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 617–621, July 1997.

Electromagnetic compensation of antenna pointing errors caused by satellite attitude error and by mechanical distortion is more advantageous than mechanical methods for large size satellite antennas. The new multibeam former (MBF) discussed here has a single set of variable phase shifters for the compensation at the common element port of multiple fixed beamformers. The MBF enables simultaneous compensation of multiple beams with the minimum number of variable phase shifters.

(53) Radiation Pattern of an Arbitrary Horizontal Antenna Above a Lossy Ground, by Y. Konishi and K. Nakagawa (Department of Electronic Engineering, Aichi College of Technology, Gamagori-shi, 443 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 622–624, July 1997.

The radiation pattern of an arbitrary horizontal antenna above a lossy ground is investigated by using the method of equivalent circuit. As an example, radiation patterns are presented for complete S dipole. The results is reasonable compared with that of RCM.

(54) A Calibration Technique for FM-CW Subsurface Radar, by H. Kasahara, H. Yamada, and Y. Yamaguchi (Faculty of Engineering, Niigata University, Niigata-shi, 950-21 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 625–627, July 1997.

In the subsurface FM-CW radar with wide-band antennas, the system error due to the frequency characteristic of the antennas affects of the range resolution performance. The system calibration of the radar is difficult because of real valued signals when correction the phase characteristic, or the frequency diversion of the system is required. We propose a simple calibration technique based on the complex signal transform, and verify its availability by experiments.

(55) An Optimization for a Card-Sized Planar Loop Antenna Using the Moment Method, by N. Ishii and K. Itoh (Faculty of Engineering, Hokkaido University, Sapporo-shi, 060 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 654–662, Aug. 1997.

A card-sized planer loop antenna (CPLA) for the paging receiver has a small absolute gain, less than -20 dBi, it is desired to improve the receiving level without changing the size of the CPLA. This paper describes an optimization of the performance indexes, for example, the radiation efficiency and three mean effective gains, for the CPLA with two feeding ports, where arbitrary voltages are possible, using the moment method. And, we discuss the performance index to optimize for good receiving level, and the performance of one point fed CPLA in comparison with two optimized solutions.

(56) Interference Suppression by Adaptive Beamforming of Satellite Borne Phased Array Antenna, by Y. Matsumoto, M. Tanaka, S. Kozono, T. Takahashi, H.-B. Li, and T. Ikegami (Communication Research Laboratory, Ministry of Posts and Telecommunications, Koganei-shi, 184 Japan): *Trans. IEICE,* vol. J80-13-II, pp. 770–776, Sept. 1997.

Radio-frequency interference (RFI) often causes problems in satellite communication systems. One way to reduce uplink interference is by adaptive beamforming of the satellite antenna; that is, adaptive nulling in the direction of RFI's. This paper describes adaptive beamforming experiments using a phased array antenna on the engineering test satellite VI (ETS-VI). The onboard beamformer was adjusted according to adaptive nulling computation which was performed on the ground. The measured pattern of the adaptivelyshaped beam was in good agreement with the prediction. An additional experiment was carried out to demonstrate the suppression of actual RFI's whose emitters were experimentally located. The measured interference suppression agreed well with the prediction, which indicated the proper effect of the adaptive beamforming for interference reduction.

(57) Impedance Characteristics of 2-Wire Helical Antenna in Normal Mode, by K. Noguchi, M. Mizusawa, T. Yamaguchi, and Y. Okumura (Division of Electrical Engineering and Electronics, Kanazawa Institute of Technology, Ishikawa-ken, 921 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 777–783, Sept. 1997.

A normal mode helical antenna is used for one of the small antennas of handy phones. The helical antenna has directivity and linear polarization as same as a monopole antenna. The helical antenna with lower height than 0.1λ has small radiation resistance and high quality factor. Therefore, the impedance matching becomes difficult. In this paper, current distributions and impedance characteristics of the helical antenna composed of two wires are analyzed. The radiation resistance of the antenna may be stepped up, and the reactance inserted into the input terminal may contribute to impedance matching. Calculation results are confirmed by experiments.

(58) Aeronautical Low-Profile Yagi-Uda Antennas, by Y. Taguchi,* Q. Chen,** and K. Sawara** (*TOYOCOM, Toyo Communication Equipment Co., Ltd., 2-1-1 Samukawa-machi, Kanagawa-ken, 253-01 Japan; **Dept. of Electrical Communications, Faculty of Engineering, Tohoku University, Aoba-ku, Sendai-shi, 980-77 Japan): *Trans. IEICE,* vol. J80-13-II, pp. 840–847, Oct. 1997.

A low-profile Yagi-Uda antenna composed of a driven inverted-F antenna and two parasitic inverted-L antennas, which is used for the antennas of SSR (secondary surveillance radar) and equipped on an airplane, is proposed. The wire antenna is analyzed by the moment method, while the printed antenna is analyzed by FDTD method. The wire type antenna has $G_d/G_r = 18.1$ dB, $G_d = 8.3$ dBi, bandwidth defined by VSWR ≤ 2 is 9.6%, with the dimension of $0.08\lambda_0$ (height) $\times 0.51\lambda_0$ (length), where G_d and G_r denote directive gain of director direction and reflector direction, respectively. It is also shown that the characteristics of the print type antenna which is fabricated on a dielectric substrate ($\varepsilon_r = 1.7$) is similar to that of the wire type antenna.

(59) Receiving Properties of Slot Array Antennas with Parasitic Slots on Dielectric Substrates, by H. Kobayashi, and Y. Yasuoka (Department of Electronics Engineering, National Defense Academy, Yokosuka-shi, 239 Japan): *Trans. IEICE,* vol. J80-B-Il, pp. 862–870, Oct. 1997.

Thin-film slot array receiving antennas for millimeter-wave and submillimeter-wave radiation were fabricated on a dielectric substrate, and antenna properties were studied theoretically and confirmed by experiments. Power gain and directivity of the antennas were discussed as functions of the number of slots and the thickness of the substrate. Mathematical simulation indicated that the highest power gains are obtained when the substrate thickness is odd multiples of the quartered dielectric wavelength. The power gain is increased by 6 dB over a single slot antenna when using a six-slot array one. These results were confirmed with the experimental results obtained at the frequencies of 64 and 700 GHz.

(60) Circularly Polarized Slot Antenna Fed by Coplanar Waveguide, by S. Matsuzawa* and K. Ito** (*Graduate School of Science and Technology, Chiba University, Chiba-shi, 263 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 871–878, Oct. 1997.

Recently, the study of the antenna elements which are suitable for a CPW-feed configuration has been popular. A CPW is suitable for the feed line of the active antenna, because a CPW is easily integrated with solid state active devices. Patch antennas, loop antennas, and slot antennas fed by CPW, which produce the linearly polarized wave have been reported, but only few attempts have so far been made at a circularly polarized printed antenna fed by CPW. In this paper, we investigate the principle of the new circularly polarized printed antenna fed by CPW by using the FDTD method.

(61) On the Analysis of a Patch Antenna Fed by Coaxial Cable Using the FD-TD Method, by T. Onishi,* T. Kashiwa,** Y. Naito,* and Y. Hosoya** (*Toyo Communication Equipment Co., Ltd., Samukawa-machi, Koza-gun, Kanagawa-ken, 253-01 Japan; **Dept. of Electrical and Electronic Eng. Kitami Institute of Technology, Kitami-shi, 090 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 921–924, Oct. 1997.

Patch antennas fed by a coaxial cable were analyzed using the FD-TD method. Some feed models and division patterns of patch were compared. It is shown that division of feed portion and edge of patch strongly affects the accuracy of analysis and that efficient computation can be carried out using the variable mesh.

(62) An Experiment of Polarization Angle Characteristics of a Dual Polarization Rectenna, by Y. Fujino,*† M. Fujita,* N. Kaya,** and N. Kusasa***†† (*Communications Research Laboratory, 4-2-1, Nukui-kitamachi, Koganei-shi, 184 Japan; ** Kobe University, Rokkodai, Nada-ku, Kobe-shi, 657 Japan; ***Musashi Institute of Technology, 1-28-1, Tamatutumi, Setagaya-ku, Tokyo, 158 Japan; †Presently, ATR Adaptive Communications Research Laboratories ; †Presently, DDI Corporation): *Trans. IEICE,* vol. J80-B-II, pp. 963–975, Nov. 1997.

In a microwave power transmission system, transmission power may be doubled easily by using a dual polarization system in which two orthogonal linear polarizations are in-

dependently used for power transmission. The polarization axes of a transmitting antenna and a rectenna can be aligned correctly between two fixed points; however, when a rectenna is mounted on a moving vehicle, the angle between the transmission polarization axis and the reception polarization axis (polarization angle) may vary due to an attitude variation of the vehicle. Also, the transmission amplitudes of vertical and horizontal polarization components may not be the same as each other. In this paper, the polarization angle dependence of the RF–DC conversion efficiency of a dual polarization rectenna is studied experimentally and with computer simulation. The computer simulation study is also carried out for the case of dual polarization transmission with an unbalanced amplitude situation. The transmission characteristics of a dual-polarization system are compared with those of a circular-polarization system to show the validity of using the dual polarization system.

(63) The Gain Characteristics of a Small Slot Antenna for Wrist-Watch Portable Radio Equipment, by Y. Okano and K. Ito (*Graduate School of Science and Technology, Chiba University, Chiba-shi, 263 Japan; **Faculty of Engineering, Chiba University, Chiba-shi, 263 Japan): *Trans. IEICE*, vol. J80-B-II, pp. 976–983, Nov. 1997.

Recently, the downsizing technology for portable radio equipment has been progressing, and now the wrist-watch type portable radio equipment is available. The antenna for such kind of equipment is highly affected by the human body, but a slot antenna can positively utilize the body effect. This paper proposes a small slot antenna installed in the band of a wrist-watch type pager. The radiation characteristics were measured and calculated for cylindrical and flat shapes, and the peak gain -13 dBd for the cylindrical slot antenna (peak gain for flat type slot was -22 dBd). The effect of curvature of the cylindrical antenna element was also studied.

(64) Compound Wire Loop Antenna for Circular Polarization, by T. Nakamura,* K. Sogano,* and Y. Murakami** (*Faculty of Engineering, Gifu University, Gifu-shi, 500-11 Japan; **Aisin Seiki Co., Ltd., Kariya-shi, 448 Japan): *Trans. IEICE*, vol. J80-B-II, pp. 984–991, Nov. 1997.

This paper proposes a new loop antenna for circular polarization. This is one wavelength rectangular loop in the form of compound wires which have different cross sections to adjacent wires. The loop antenna placed close to the ground plane is approximately analyzed with a transmission line model. An equivalent circuit is derived using different characteristics impedances transformed from the wire cross section of each loop section, and a simple circular polarization condition for the characteristic impedances and the height of the loop is obtained. A simple antenna made of two radius wires is designed, and the validity of this model is proved numerically by the moment method. Experimental results are also in good agreement with the theory.

(65) Resonant Frequency and Radiation Efficiency of Meander Line Antenna, by T. Endo, Y. Sunahara, S. Satoh, and T. Katagi (Mitsubishi Electric Corporation, Kamakura-shi, 247 Japan): *Trans. IEICE*, vol. J80-B-II, pp. 1044–1049, Dec. 1997.

Meander line dipole antenna is useful for reducing the antenna size by bending its element into a meander configuration. In this paper, we consider a meander line dipole antenna to be an inductance-loaded dipole antenna. By a number of experiments, we can express the equation between the resonant frequency of meander line dipole antenna and many parameters of its configuration, and one of radiation efficiency of meander line dipole antenna. Consequently, we can determine the optimum parameters of meander line dipole antenna for the conditions given.

(66) Multiplates: Low Profile Antenna, by J.-W. Yang, S. Tokumaru, and T. Iijima (Faculty of Science and Technology, Keio University, Yokohama-shi, 223 Japan): *Trans. IEICE*, vol. J80-B-II, pp. 1050–1057, Dec. 1997.

A low profile multiplates antenna has wide-band characteristics but no theoretical analysis has been known on the multiplates antenna because of its complicated structure. In this paper, numerical analysis of the low-profile multiplates antenna was studied using the FDTD method. The FDTD results concerning impedance and radiation pattern are compared with measured values. The calculated band width of this antenna is 48%. The radiation pattern is null in the upper side and omni-directional in the horizontal direction.

(67) A Reflector Lens Antenna Consisting of an Artificial Dielectric, by Y. Mukoh,$*$ T. Nojima,** and N. Hasebe* (*College of Science and Technology, Nihon University, Funabashi-shi, 274 Japan; **Takaoka Electric Mfg. Co., Ltd., Tokyo, 101 Japan): *Trans. IEICE*, vol. J80-B-II, pp. 1058–1065, Dec. 1997.

Reflector-lens antennas consisting of an artificial dielectric are proposed. The paper describes the design equation of the lens surface using geometrical optics, simulation of focusing characteristics of the lens using the lay trace method and design examples of an offset-lens antenna (offset angle: 30°) and a three beam (zenith and tiled beams in direction of north and east) lens antenna having a diameter of 12.5 wavelength, respectively. From the experimental results, the offset-lens antenna yields a gain of 28.6 dB, and the three beam-lens antenna shows a gain of 27.5 dB in each beam.

(68) Proposal of Optical Antennas with Shaped Reflectors and the Characteristics Analysis Considering Manufacturing Errors, by T. Takano,* A. Kojima,** and Y. Koyama*** (*Institute of Space and Astronautical Science, Sagamihara-shi, 229 Japan; **Mitsubishi Heavy Industries, Ltd., Tokyo, 100 Japan; ***Hitachi, Ltd., Yokohama-shi, 244 Japan): *Trans. IEICE*, vol. J80-B-II, pp. 1066–1075, Dec. 1997.

This paper studies the constitution and associated problems of efficient optical antennas which are required in optical intersatellite links, laser radars and so on. The boresight gain which is the most important for the optical antenna can be maximized by the uniform field distributions of the amplitude and phase on the aperture. First, it is proposed to shape the surfaces of an optical antenna to optimize both phase and amplitude distributions. The design is accomplished on the basis of the method adopted in the microwave region. Next, the antenna characteristics degradation due to mechanical errors is estimated, as the actual reflector surfaces should have the

accuracy of the order of optical wavelengths. The procedure depends on numerical analysis on the basis of the error values by present manufacturing technologies. The trade-off between the mechanical errors and electrical characteristics and the limitation to the reduction of the antenna length are clarified. Material relevant losses such as reflection loss is also described.

(69) Quasi-Optical Antenna-Mixer System Fed by Coplanar Wave-Guide, by T. Nishimura, K. Tsuchida, and N. Ishii (Faculty of Engineering, Hokkaido University, Sapporo-shi, 060 Japan): *Trans. IEICE*, vol. J80-B-II, pp. 1076–1083, Dec. 1997.

In the quasi-optical antenna mixer system, the IF signal is generated immediately after the RF and LO signal are received spatially. The dual frequency operating microstrip antenna system is proposed in order to realize the quasi-optical antenna mixer system. The proposed system is fed by the coplanar wave-guide loaded by the mixer-diode. Therefore the RF and LO signals are received on each side of the substrate, respectively. The receiving system that operates in the millimeter-wave band has been designed and verified using an EM simulator. The dual frequencies and mixing operations are verified experimentally.

(70) Receiving Property on Multielement Quasi-Optical Antenna-Mixer System, by T. Nishimura, K. Tsuchida, and N. Ishii (Faculty of Engineering, Hokkaido University, Sapporo-shi, 060 Japan): *Trans. IEICE*, vol. J80-B-II, pp. 1084–1090, Dec. 1997.

A novel receiving system with a multielement quasi-optical antenna mixer is proposed. The IF signal is generated immediately after the RF and LO signal are spatially received in the system. By changing the angle or the frequency of the incident LO signal, it is possible to scan the direction of the incident RF signal. By using our system, the loss can be largely reduced and the design is simplified, as some RF circuits are no longer needed. The operating principle is verified by using the four-element model both theoretically and experimentally in the microwave band.

(71) Measurement of Antenna Factor of Log Periodic Dipole Array Antenna by Near-Field Reference Antenna Method, by K. Fujii,* T. Iwasaki,* S. Ishigami,* and S. Usuda** (*Department of Electronic Engineering, The University of Electro-Communications, Chofu-shi, 182 Japan; **Voluntary Control Council for Interference by Data Processing Equipment and Electronic Office Machines, Tokyo, 105 Japan): *Trans. IEICE*, vol. J80-B-II, pp. 1091–1098, Dec. 1997.

It is pointed out that an antenna factor defined by the ratio of the incident electric field strength to the output voltage at the reflection-free load can be calibrated by the reference antenna method. The antenna factor calibration for a log-periodic dipole array antenna is investigated in the frequency range of 600 MHz to 2 GHz. The calibrated antenna factor depends on the position of the reference antenna. In order to avoid the dependency of reference antenna position, an enough far distance is required between the transmitting and receiving antennas. However, in such a far-field measurement, the measurement site imperfections such as reflection might become ineligible sources of calibration error. The field-transfered reference antenna method is proposed to cope with the above described problems. The far-field attenuations between transmitting and receiving antennas are evaluated from the measured near-field attenuations with the field transfer factors (FTF) obtained by the method of moment. The validity of this method is made sure experimentally.

(72) Post Processing for Millimeter Wave Radar Images Using Feedforward Neural Network, by K. Watabe, K. Shimizu, M. Yoneyama, and K. Mizuno (*Research Institute of Electrical Communication, Thoku University, Sendai-shi, 980-77 Japan; **Faculty of Engineering, Toyo University, Kawagoe-shi, 350 Japan): *Trans. IEICE*, vol. J80-C-I, pp. 343–353, July 1997.

An active-mode mm-wave (60 GHz) imaging system with Yagi-antenna-type imaging array has been developed. A signal processing using a neural network has been successfully introduced to recognize and to reconstruct images distorted with coherent mm-wave illumination. With 10×10 sampling points the recognition rate of 98% has been obtained for the objects of 10 different alphabetical letters and five teaching trials. The rate of success to reconstruct the alphabet capital letters from their degraded millimeter image has been 47 shown over 80% in case of eight different letters reconstruction.

(73) Implementation of a Digital Signal Processor in a DBF Self-Beam-Steering Array Antenna, by T. Tanaka,*† R. Miura,*†† and Y. Karasawa*††† (*ATR Optical and Radio Communications Research Laboratories, Radio Communications Department, Kyoto-fu, 619-02 Japan; †Presently, with Hewlett-Packard Japan Ltd., Kawasaki-shi, 213 Japan; Presently, with Communications Research Laboratory, Kyoto-fu, 619-02 Japan; †††Presently, with ATR Adaptive Communications Research Laboratories, Kyoto-fu 619-02 Japan): *IEICE Trans. Commun.*, vol. E80-B, pp. 166–175, Jan. 1997.

We have proposed a digital beamforming (DBF) self-beam-steering array antenna which features maximal ratio combining enabling it to efficiently use the received power or to rapidly track the desired signal. The DBF self-beam-steering array antenna utilizes digital signal processing with an active array antenna configuration. ASIC implementation of the digital signal processor is inevitable for DBF antenna application in practical mobile communications environments. In this paper, we present a scheme for implementing a digital signal processor in ASIC's using ten FPGA's (field programmable gate arrays) for the DBF self-beam-steering array antenna. Results of some experiments obtained in a large radio anechoic chamber are shown to confirm a basic function of the system.

(74) An Improved Circuit Theory for the Analysis of Longer Coplanar Dipole Antennas, by A. I. Imoro,* Y. Kani,** N. Inagaki,* and N. Kikuma* (*Department of Electrical and Computer Engineering, Nagoya Institute of Technology, Gokiso-cho, Showa-ku, Nagoya-shi, 466 Japan; **Toyota Auto Body Co. Ltd., 100, Kanayama, Ichiriyama-cho, Kariya-shi, 448 Japan): *IEICE Trans. Commun.*, vol. E80-B, pp. 389–394, Feb. 1997.

The valid region for the application of the conventional *improved circuit theory* (ICT) in the analysis of wire antennas is established. To further extend the application of ICT to

the analysis of much longer antennas, Tai's trial function is used to derive new formulas for the impedance matrix. Unlike the conventional ICT trial function, Tai's trial functions lead to input impedances which are finite irrespective of antenna length. Results of the new ICT impedance formulas are comparable in accuracy with the general method of moments. Moreover, since all the elements of the new formula have been expressed in closed-form, the resulting ICT algorithm is still superior in terms of computer running time with lesser storage requirement compared to other conventional methods like method of moments. This world enhance ICT applications in CAD/CAE systems.

(75) Beam Forming Characteristics of a Waveguide-Type Optical Phased Array Antenna, by Y. Murakami, K. Inagaki, and Y. Karasawa, (ATR Optical and Radio Communications Research Laboratories, Kyoto-fu, 619-02 Japan): *IEICE Trans. Commun.,* vol. E80-B, pp. 617–624, Apr. 1997.

This paper presents the beam forming characteristics of an optical waveguide-type phased array antenna. Four linearly arranged array antenna was monolithically fabricated on one $LiNbO_3$ substrate containing variable power dividers (VPD's) and optical phase shifters (OPS's). The amplitude and the phase of each antenna element was controlled by applying dc voltage on each VPD and OPS. Open ends of Ti-indiffused waveguides were used as antenna elements. This antenna was designed to operate at 1.3-μm wavelength band. Experimental results confirm the good beam forming capability of optical phased array antennas.

(76) A New High Gain Circularly Polarized Microstrip Antenna with Diagonal Short, by H. Ohmine, H. Mizutamari, Y. Sunahara (Antenna and Microwave Engineering Group, Kamakura Works, Mitsubishi Electric Corporation, Kamakura-shi, 247 Japan): *IEICE Trans. Commun.,* vol. E80-13, pp. 1090–1097, July 1997.

A new configuration of high-gain circularly polarized microstrip antenna with a diagonal short and its analysis using boundary element method with a radiation load are presented. The center of a radiating patch is shorted with a 45° diagonal offset for not only obtaining a high gain but exciting a circular polarization. This configuration leads to achieving high gain with keeping a very low profile configuration. Boundary element method with radiation load which takes into account the effect of radiation loss is employed to analyze this complicated configuration. The radiation load, which is very important when boundary element method is applied to antenna analyses, can be obtained from radiation admittance using recurring technique, so that the accuracy of the antenna characteristic calculations can be improved. This antenna was designed and tested in the L-band and good characteristics, axial ratios and radiation patterns, have been verified.

(77) A Single-Layer Linear-to-Circular Polarization Converter for a Narrow-Wall Slotted Waveguide Array, by K.-S. Min,* J. Hirokawa,** K. Sakurai,** M. Ando,** N. Goto,*** and Y. Hara**** (*Department of Radio Science and Engineering, College of Sciences and Engineering, Korea Maritime University, #1 Dongsam-dong,Yeongdo-ku, Pusan 606-791, Korea; **Department of Electrical and Electronic Engineering, Faculty of Engineering, Tokyo Institute of Technology, Tokyo, 152 Japan; ***Department of Electronics and Systems, Faculty of Engineering, Takushoku University, Hachioji-shi, 193 Japan ; ****Japan Radio Co., Ltd., Mitaka-shi, 181 Japan): *IEICE Trans. Commun.,* vol. E80-13, pp. 1264–1272, Aug. 1997.

This paper describes the characteristics of a one-dimensional narrow-wall slotted waveguide array with a single-layer linear-to-circular polarization converter consisting of a dipole array. An external boundary value problem of one slot and three dipoles, which approximates the mutual coupling between the dipole array and an edge slot extending over three faces of a rectangular waveguide, is formulated and analyzed by the method of moments; design of polarization conversion is conducted for this model as a unit element. If every unit element has perfect circular polarization, grating lobes appear in the array pattern due to the alternating slot angle: these are suppressed in this paper by changing the dipole angle and degrading the axial ratio of the unit element. The validity of the design is confirmed by the measurements. The dipole array has negligible effects upon slot impedance: the polarization conversion for existing narrow-wall slotted arrays is realized by add-on dipole array.

(78) Interference Cancellation Characteristics of a BSCMA Adaptive Array Antenna with a DBF Configuration, by T. Tanaka,*† R. Miura,*†† I. Chiba, *† and Y. Karasawa*††† (*ATR Optical and Radio Communications Research Laboratories, 2-2 Hikaridai, Seika-cho, Kyoto-fu, 619-02 Japan; †Presently, with Mitsubishi Electric Corporation; ††Presently, with Communications Research Laboratory; †††Presently, with KDD R&D Laboratories): *IEICE Trans. Commun.,* vol. E80-B, pp. 1363–1371, Sept. 1997.

We have developed a beam space CMA (constant modules algorithm) adaptive array antenna system (BSCMA adaptive array antenna) that may be suitable for mobile communications. In this paper, we present experimental results of interference cancellation characteristics using the developed system. The experiment was carried out in a large radio anechoic chamber, while desired and interference signals were transmitted to the system. We focused on the characteristics of capture, convergence and tracking in adaptive processing. The experimental results show excellent interference cancellation characteristics, and demonstrate that the BSCMA adaptive array antenna has a greater feasibility to be applied practically in mobile communications.

(79) Transmission-Line Coupling of Active Microstrip, Antennas for One- and Two-Dimensional Phased Arrays, by R. ISPIR,* S. Nogi,* M. Sanagi,* and K. Fukui** (*Faculty of Engineering, Okayama University, Okayama-shi, 700 Japan; **Kawasaki University of Medical Welfare, Kurashiki-shi, 701-01 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 1211–1220, Sept. 1997.

Several types of transmission-line coupling are analyzed to use in one- and two-dimensional active antenna arrays, and a method is developed to scan the beam of the arrays using the mutual locking theory. To compensate the undesired effect of strong radiative coupling of the nearest neighbor elements on the phased array performance, addition of resistive

stubs to the end elements is proposed. In a 1×4 array it was observed that after the connection of resistive stubs, the scanning range of the array increased considerably. The effect of oscillator amplitudes on the phased array behavior is explored numerically. In the experiments main beam of 2×2 and 3×3 active antenna arrays were steered up to 25 and 15°, respectively, in the H-plane.

(80) Analysis of Coupling between CPW-Fed Slot Antennas Using FDTD with PML Boundary Conditions, by S. Saario,*† Y. Qian,** and E. Yamashita** (*Radio Science Laboratory, Faculty of Engineering, School of Microelectronic Engineering, Griffith University, Nathan Campus, Kessels Road, Brisbane QLD 4111, Australia; **Faculty of Electronic Engineering, University of Electro-Communications, 1-5-1 Chofu-gaoka, Chofu-shi, 182 Japan; †Presently, with the University of Electro-Communications): *IEICE Trans. Electron.*, vol. E80-C, pp. 1608–1613, Dec. 1997.

A rigorous analysis of coupling between two twin-slot antennas using the finite-difference time-domain (FDTD) method is reported for the first time. The phase cancellation effect (PCE) is used to reduce the coupling due to the TM_0 surface wave mode between the coplanar waveguide (CPW) fed cascade-connected twin-slot antennas. To confirm the effectiveness of this approach, coupling between single-slot and twin-slot elements separated by $\lambda_0/2$ was analyzed. The coupling between the two single-slot antennas was $S_{21} = -30.2$ dB. For the case of two twin-slot antennas, the coupling was found to be -37.8, 7.6 dB below that of the single-slot antennas. The phase cancellation effect of surface waves is significant in reducing coupling between two twin-slot antennas, in addition to minimizing power loss into substrate modes. A memory optimized implementation of the FDTD method with the Berenger perfectly matched layer (PML) absorbing boundary condition (ABC) was used to for the numerical analysis.

IV. Microwave/Lightwave Propagation and Scattering

(1) Contour Reconstruction of a Two-Dimensional Non-starlike Conducting Object, by M.-Y. Zhang, B.-W. Lu and W.-M. Song (Institute of Electronics, Academia Sinica, Beijing, P.R.C.): *AES,* vol. 2, no. 12, pp. 5–9, Dec. 1997.

The Colton–Monk method for treating inverse electromagnetic and acoustic problems is briefly introduced and extended from the case of two-dimensional starlike object to the case of non-starlike object. The more general parameterization of the contour of the scatter is applied to arbitrary smooth object. Computer simulation results demonstrate the effectiveness of the modified method.

(2) An Iterative Imaging Method for 2-D Perfectly Conducting Object Embedded in a Dielectric Region, by S.-Y. Shi, Q.-L. Li, and D.-B. Ge (Xidian University, Xi'an, P.R.C.): *AES,* vol. 25, no. 9, pp. 105–108, Sept. 1997.

A novel imaging method to reconstruct a 2-D perfectly conducting object embedded in a dielectric region is presented. Based on the boundary integral equations established for scattering problem of an embedded conducting object, the Newton–Kantorovitch method and MOM are used to derive the basic inverse scattering equations.

(3) Multiplaten Z-Buffer Technique for Analysis of Electromagnetic Scattering, by J.-L. Hu,* Y. Ma,* S.-M. Lin,* and W.-B. Wang** (*Northwestern Polytechnical University, Xi'an, P.R.C.; **Xi'an Jiaotong University, Xi'an, P.R.C.): *AES,* vol. 25, no. 9, pp. 47–50, Sept. 1997.

A new technique—multiplaten Z-buffer technique—is presented. This technique combines the computer graphics with the analysis of electromagnetic scattering. Employing the CAD-geometry based on the multiplaten Z-buffer technique, the hidden-surface elimination and the ray tracing problems can be solved, which are two formidable tasks in the radar cross section analysis of the complex body.

(4) Tanh Transformation for Electromagnetic Scattering, by J.-H. Hu,* S.-M. Lin,* and W.-B. Wang** (*Northwestern Polytechnical University, Xi'an, P.R.C.; Xi'an Jiaotong University, Xi'an, P.R.C.): *AES,* vol. 25, no. 6, pp. 30–33, June 1997.

Numerical computation of Fresnel function and Maliuzhinets function is a difficult and important problem in electromagnetic scattering by a wedge with impedance faces. This paper employs the transformation to successfully solve this problem. The comparison between the calculated result and the precision values shows that the computing precision of our method is high and its speed is rapid.

(5) Analysis of Electromagnetic Scattering by Irregularly Shaped Objects, by J.-M. Xiao and C.-H. Liang (Xidian University, Xi'an, P.R.C.): *AES,* vol. 25, no. 6, pp. 16–19, June 1997.

This paper analyzes the scattering of an electromagnetic wave with a centimetric wave-length by an object whose surface is irregular. The angular dependance of the intensity scattered is obtained in the framework of the eikonal picture. Using different types of surface, the results show a correlation between the irregularities and the local maxima in the intensity spectrum and a systematic backscattering enhancement.

(6) New Approaches to Near-Zone to Far-Zone Field Transformation in Time-Domain Scattering Problems, by J.-F. Ma and B.-Q. Gao (Beijing Institute of Technology, Beijing, P.R.C.): *AES,* vol. 25, no. 3, pp. 121–125, Mar. 1997.

Focused on the methods of near-field to far-field transformation in solving scattering problems by FDTD method, two new approaches are presented. One is directly obtaining scattered far field by adopting Stratton–Chu integral formula. Another method is applying Laplace transformation and convolution technique which leads to a unified formula for scattered far field in timedomain for both 2-D and 3-D scattering problems, and makes 2-D problem a special case of 3-D problem.

(7) The Scattering Field Behavior of Two Bianisotropic: Chiral Cylinders, by W.-Y. Yin and W. Wan (Northwestern Polytechnical University, Xi'an, P.R.C): *AES,* vol. 25, no. 3, pp. 87–90, Mar. 1997.

The field distributions for the inner and outer regions of two parallel bianisotropic chiral cylinders are derived using the boundary-value technique for electromagnetic analysis, and the obliquely incident wave is assumed to be either TM or TE polarization. Also, all the elements of Mueller scattering matrix are examined, and the effects of chirality and nonreciprocity parameters are demonstrated in detail.

(8) A Hybrid Numerical Simulation Method for the Time-Domain EM Scattering Problem of an Inhomogeneous Half Loss Space, by K. Lan, Y.-S. Zhao, and W.-G. Lin (Institute of Applied Physics, UESTC, Chengdu, P.R.C): *AES,* vol. 25, no. 3, pp. 41–44, Mar. 1997.

A hybrid numerical method for simulating the time-domain EM scattering of inhomogeneous half loss space is given. In free-space, FD-TD method is used, while in loss layers, the wave equation is reduced to the diffusion equation, and the Dufort–Frankle finite-difference method with irregular grids is used. The combination of these two methods provides an effective scheme to model the propagation of arbitrary EM pulses in deep loss layers.

(9) Analysis of Plane Wave Diffraction by Dielectric Gratings with MEI, by J. Chen and W. Hong (State Key Laboratory of Millimeter Waves, Southeast University, Nanjing, P.R.C.): *JCIC,* vol. 18, no. 6, pp. 25–30, June 1997.

Plane wave diffraction by arbitrarily shaped dielectric gratings is first analyzed by the MEI method. The Green function in periodic space is employed to determine the MEI according to the periodicity of the structure. The finite difference equation is used to the inhomogenuity of the dielectric in a unit cell.

(10) Iterative Algorithm Based on Measured Equation of Invariance for Scattering by Multicylinders Coated with Media, by J. Chen and W. Hong (State Key Laboratory of Millimeter Waves, Southeast University, Nanjing, P.R.C.): *JCIC,* vol. 18, no. 8, pp. 1–5, Aug. 1997.

A novel iterative algorithm based on measured equation of invariance is proposed for the scattering analysis of multicylinders coated with media. A new iterative procedure is combined with the MEI method to make full use of the properties of MEL As the MEI coefficients can be reused, both the storage space and computing time are reduced greatly. Results by this method are in good agreement with those available.

(11) Microcellular Radio Propagation Prediction Using Ray Tracing Technique, by T. Li, M. Lou, H.-X. Wang, and B.-H. Li (Shanghai Jiao Tong University, Shang-hai, P.R.C.): *JCIC,* vol. 18, no. 11, pp. 1–7, Nov. 1997.

This paper presents a "from plane to space" ray tracing model which fits for the micro-cellular environment. The model used a 2-D ray tracing algorithm instead of the complex 3-D algorithm to solve the space problem. An auto-build method of the buildings database is also developed. Good agreement between prediction and measurement is found.

(12) Extraction of Radar Target Waveform Feature Using Chirp-z Transform, by Y.-D. Wang and X.-G. Li (Institute of Millimeter Wave Near Sensing Technique, Nanjing University of Science and Technology, Nanjing, P.R.C.): *JIMW,* vol. 16, no. 3, pp. 231–235, June 1997.

The video waveform feature of high-resolution radar was discussed. Using the Chirp-z transform, the extraction of high-resolution waveform feature was presented. Two types of practical millimeter-wave high-resolution radar target waveforms were studied by Chirp-z transform and Fourier transform.

(13) Difference Equations Constructure in Complex Media and Application to Electromagnetic Scattering, by Z.-N. Chen, W. Hong, Z.-P. Qian and W.-X. Zhang (Southeast University, Nanjing, P.R.C.): *JAS,* vol. 15, no. 1, pp. 9–18, Mar. 1997.

This paper establishes difference equations of electromagnetic scattering problem in complex media by integral interpolation method to partial differential equation. The process of modelling and FDE's construction applied in electromagnetic scattering problems in anisotropic and rotary wave media are given.

(14) A Novel Method for Microwave Imaging of Two-Dimensional Targets, by A.-Y. Qing, J. Li, and L. Ren (Institute of Electromagnetic Field and Microwave Technology, Southwest JiaoTong University, Chengdu, P.R.C.): *JAS,* vol. 15, no. 3, pp. 253–258, Sept. 1997.

The microwave imaging of two-dimensional targets is discussed. By volume equivalence principle, a system of integral equations is obtained. They link the media's permittivity and conductivity with scattering field and total. Then, the inversion equation is obtained after taking variation on these integral equations. The effect of random noise is also discussed.

(15) An Improved Method on Time-Domain Born Iteration, by W.-H. Yu,* Z.-Q. Peng,** and S.-Z. Li* (*Beijing Institute of Technology, Beijing, P.R.C.; **Beijing Remote and Information Institute, Beijing, P.R.C.): *JAS,* vol. 15, no. 3, pp. 299–304, Sept. 1997.

A new method for improving Born iterative method is presented. The frequency compensation technique is used to solve nonlinear inverse scattering problem for two-dimensional lossless dielectric inhomogeneity using time-domain data. The transmitting boundary condition and the superabsorption technique in FDTD are used to reduce the error of scattering fields.

(16) Detection of Two-Dimensional Objects in Half Space, by A.-Y. Qing, J. Li, and L. Ren (Institute of Electromagnetic Theory and Microwave Technology, Southwest JiaoTong University, Chengdu, P.R.C.): *JAS,* vol. 15, no. 4, pp. 394–401, Dec. 1997.

The detection of shallow two-dimensional objects in layered media by using time domain scattering data is considered. A volume integral equation which relates the scattering fields in time domain with the permittivity of the objects is obtained by volume equivalence principle. The equation is transferred into frequency domain and the inversion equation is obtained after discretion. Several examples are given to show the ability of this method to invert arbitrarily shaped objects.

(17) Numerical Study for LRCS of Complex Object, by X.-D. Zhang, Z.-S. Wu, and C.-K. Wu (Xidian University, Xi'an, P.R.C.): *JE,* vol. 19, no. 5, pp. 709–712, Sept. 1997.

Based on the characters and engineering modeling of laser radar cross section for the object with rough surface, some methods of geometric modeling and hidden process for complex object are analyzed and discussed. The angular distributions of backscattering of laser radar cross section for airplane model are computed at 1. 06 μm. The numerical results are in good agreement with experimental data.

(18) Scattering by Fractal Grating, by Z.-S. Wu and L. Xu (Xidian University, Xi'an, P.R.C.): *JE,* vol. 19, no. 4, pp. 516–521, July 1997.

Based on Fresnel–Kirchhoff theory, the electromagnetic scattering from fractal gratings, which have structure on uniform Cantor sets or Siepinski carpet, is discussed. The scattering intensities of one-dimensional and two-dimensional fractal grating with different fractal dimension are calculated and their properties on spatial frequency distribution are then analyzed. The numerical results illustrate the fractal characteristics and frequency selectivities.

(19) The FDTD Analysis for the Millimeter Wave Propagation in a Optically Controlled Rectangular Dielectric Waveguide, by X.-Y. Wu,* S.-P. Zhou,** and D.-M. Xu* (*Dept. of Electronic Engineering, Shanghai University, Shanghai, P.R.C.; **Dept. of Physics, Shanghai University, Shanghai, P.R.C.): *JE*, vol. 19, no. 4, pp. 522–526, July 1997.

Following the strictly solving the continuity equation of the photo-induced carriers, the FDTD analysis for millimeter-wave propagation in an optically controlled rectangular dielectric waveguide was presented. Excellent agreements between numerical results and experiments were found.

(20) Virtual-Ray Method and its Application in the Plane Wave Scattering by an Impedance Wedge, by M.-Y. Zhang and K.-Y. Feng (Institute of Electronics, Academia Sinica, Beijing, P.R.C.): *JE*, vol. 19, no. 1, pp. 97–104, Jan. 1997.

The virtual-ray method for treating HF electromagnetic scattering problems is derived from the plane wave of free space, and the plane wave scattering by an impedance wedge is studied. The concept of generalized circle is introduced so that the complete amplitude function is obtained.

(21) A Study on Direct EM Scattering of Two-Dimensional Inhomogeneities Buried in a Loosy Stratified Medium, by W.-Y. Wang and S.-R. Zhang (Institute of Electronics, Academia Sinica, Beijing, P.R.C.): *JE*, vol. 19, no. 1, pp. 105–111, Jan. 1997.

Direct TM-scattering problem of two-dimensional inhomogeneities buried in a loosy stratified medium is presented. The Green's function of a filament buried in a loosy stratified medium is derived and an electric field integral equation is constituted for an equivalent current caused by the differences between the inhomogeneities and the stratified medium. Numerical results are given to model inhomogeneous underground tubes embedded in a stratified medium, and to describe the scattering field affected by different factors.

(22) Study on the Electromagnetic Scattering Properties of Underground Three-Dimensional Objects, by G.-Y. Fang,* Z.-Z. Zhang,* and W.-B. Wang** (*China Research Institute of Radiowave Propagation, Xinxiang, P.R.C.; **Xi'an Jiaotong University, Xi'an, P.R.C.): *JM*, vol. 13, no. 1, pp. 8–14, Mar. 1997.

The (FD-TD) formulas for calculating the relation properties of cylinder antennas loaded by lumped resistances are deduced. The transient electromagnetic scattering properties of 3-D objects buried in dispersive media are analyzed. The influence of the parameters of dispersive media and buried objects on the scattering signals are studied. The mechanism of the transient scattering phenomenon produced by buried 3-D thin conductor is analyzed.

(23) Techniques of RCS Data Processing and Reverse Evaluation for Scaling Model Testing of Stealthy Targets, by H.-W. Liu,* Z.-D. Shi,* Z. Wu,** and Z.-H. Lu** (*University of Electronic Science & Technology of China, Chengdu, P.R.C.; **Beijing University of Aeronautics& Astronautics, Beijing, P.R.C.): *JM*, vol. 13, no. 1, pp. 15–19, Mar. 1997.

A novel technique for reverse evaluation of RCS of Stealthy targets by using measured data of its scaling down model is introduced. The reverse evaluating mathematics equations, data processing means, reverse evaluation computing method and some tested and calculated results are given; and the tested and calculated curves agree fairly well with each other.

(24) Study on the TM Scattering Problems of Conducting Targets Coated with Absorbing Materials by Using CFDTD, by Y.-S. Zhang,* W.-B. Wang,* and L.-M. Ma** (*Xi'an Jiaotong University, Xi'an, P.R.C.; **The Third Middle School of Puyang, Henan, P.R.C.): *JM*, vol. 13, no. 2, pp. 97–102, June 1997.

The contour path meshing technique in two-dimensional FDTD algorithm is investigated in detail and the iterative equations of the fields on the grids near the surface of conducting targets coated with absorbing materials are derive. For the two-dimensional TM case, the RCS and nearby scattering fields of some conducting targets coated with or partially coated with absorbing materials are calculated.

(25) The Application of Periodic Wavelet in Electromagnetic Scattering, by Y. Xu and T.-J. Liu (Beijing Institute of Environmental Feature, Beijing, P.R.C.): *CJRS*, vol. 12, no. 2, pp. 142–148, June 1997.

Coiflet periodic wavelet combined with moment method is applied for the computation of the electromagnetic scattering of 2-D objects. The periodic wavelet is used as basis and testing functions in the integral equations. Taking advantage of the vanishing-moment property of coiflet, accurate results can be obtained quite quickly. The current distribution on an infinitely long square cylinder illuminated by plane wave is computed by periodic wavelet-moment method, and good agreement has been seen between the result of the present method and the published data.

(26) Measurement and Analysis for the Dielectric Constant of Ground Materials, by S.-F. Kang,* F. Sun,* X.-Y. Luo,* Z.-Z. Zhang,* and G.-L. Tian** (*China Research Institute of Radiowave Propagation, Xinxiang, P.R.C.; **Institute of Remote Sense, Academia Sinica, Beijing, P.R.C.): *CJRS*, vol. 12, no. 2, pp. 161–168, June 1997.

Analysis for the dielectric constant measurement system with coaxial line probe and measurement methods of the dielectric constant for ground materials are presented. The measurement and analysis results of some typical ground material (sand, stone, tree, cotton, leave) have been given. The measurement data provided can be used in the study of the scatter and radiation characteristics of the ground materials.

(27) Diffraction-Scattering Field of Conductor Wedge Loading Loss Cylinder, by W.-D. Wang (Guilin Institute of Electronic Technology, Guilin, P.R.C.): *CRJS*, vol. 12, no. 2, pp. 225–232, June 1997.

The diffraction-scattering field of conductor wedge loading loss cylinder are analyzed by expanding factor method, and the theoretical analysis for diffraction field are calculated numerically by the medium constant, cylindrical radius and the conductor wedge angle as parameters, also the convergence of series solution is discussed.

(28) A Novel Ionospheric Delay Correcting Method for GPS Single-Frequency Navigation and Positioning Applications, by M.-Y. Zhang, B.-W. Lu, and W.-M. Song (Institute of Electronics, Academia Sinica, Beijing, P.R.C.): *CJRS*, vol. 12, no. 3, pp. 254–259, Sept. 1997.

A novel ionospheric delay real-time estimating and correcting method is proposed which takes advantage of real-time pseudorandom code and carrier phase observation data obtained by a single-frequency GPS receiver. The procedure to determine the phase integer ambiguity using a local ionospheric delay model and real-time observation data is highlighted.

(29) The Geometric Optics Method in Random Inhomogeneous Media, by X.-P. Wu (Beijing University of Posts & Telecommunications, Beijing, P.R.C.): *CJRS*, vol. 12, no. 3, pp. 275–279, Sept. 1997.

A new criterion of geometric optics method validity in random refractive media has been developed. The criterion is described as no ray intersections between any two adjacent wave fronts. It has been shown that the validity range of geometric optics method strongly depends on the fluctuation of media dielectric constant.

(30) Analyzing Properties of Wave Propagation in Microcellular Multipath Scattering Environment, by H.-B. Zhu* and Y.-G. Gao** (*Nanjing University of posts& Telecommunications, Nanjing, P.R.C.; **Beijing University of posts& Telecommunications, Beijing, P.R.C.): *CJRS*, vol. 12, no. 3, pp. 321–327, Sept. 1997.

Having analyzed the characteristics of multipath dispersive channel, the paper built up the equivalent physical model of mobile radio channel in urban microcellular multipath scattering environment with the help of Fresnel theory and the ray method. Based on this, the propagation properties of mobile radio wave as well as the wave propagation parameter have been analyzed and studied.

(31) A Constrain Condition for Analytically Introducing Incident Fields of FDTD Method, by Q.-L. Li and D.-B. Ge (Xidian University, Xi'an, P.R.C.): *CJRS*, vol. 12, no. 3, pp. 334–337, Sept. 1997.

A constrain condition for analytically interdicting incident fields of FDTD method is obtained. It indicates that the incident wave is exerted point by point time-lag scheme instead of simultaneously on the boundaries of total fields. The numerical results show that the analytical method has the same computation precision as 1D-FDTD method, especially it can be used in solving the problems of half-space plane wave scattering.

(32) The EM Scattering of Two-Dimensional Fractal Surface in Far Region, by M.-X. Wang, J. Li, and L. Ren (Institute of Electromagnetic Theory and Microwave Technology, Southwest Jiaotong University, Chengdu, P.R.C.): *CJRS*, vol. 12, no. 4, pp. 380–384, Dec. 1997.

Fractal function is used to characterize two-dimensional rough surface. The calculating formula are derived and the numerical results are given. The distributions of scattering fields in far region are obtained.

(33) Distributions of Rain Attenuation for Ku Band Broadcasting-Communication Satellite in China, by S.-B. Qiu, R.-Y. Zhao, and J.-H. Chen (China Research Institute of Radiowave Propagation, Xinxiang, P.R.C.): *CJRS*, vol. 12, no. 4, pp. 428–435, Dec. 1997.

The distributions of rain attenuation are given for broadcasting-communication satellite in Ku band under the conditions of circular and linear polarization. These distributions are computed from data of one minute rainfall rate at 65 stations by means of ITU-R prediction formula of attenuation by rain.

(34) Ionosphere Faraday Effect's Influence on Satellite Communication, by W.-M. Wang and H.-G. Zhu (Nanjing Research Institute of electronics Technology, Nanjing, P.R.C.): *CJRS*, vol. 12, no. 4, pp. 453–457, Dec. 1997.

Ionosphere Faraday effect's influence on linear polarization satellite communication systems are analyzed. Deflection angle and polarization for some cities in China are calculated. The calculated results and the measured data are in good agreement.

(35) An Analysis of Microwave Active Circuit Using the Extended FDTD Method, by J. S. Park,* S. S. Nam,** S. G. Jang,* H. J. Lee,** and Y. K. Chin* (*Dept. of Elec. Eng., Dankook Univ., Seoul, Korea ETRI, Taejon, Korea): *JKICS*, vol. 22, no. 12, pp. 2736–2771, Dec. 1997.

In this paper, the extended finite difference time domain (FDTD) algorithm is applied to carry out full-wave analysis of a microwave amplifier circuit. The active device included in the amplifier is modeled by equivalent current sources. Equivalent current sources are characterizing interaction between electromagnetic waves and active devices and can be directly incorporated into the FDTD algorithm. To confirm this analysis, an amplifier is implemented. The FDTD simulation shows good agreement with measured results.

(36) A Study of Coupling Mechanism Between Two Dipoles Integrated within a Conductor-Backed Thin Dielectric Layer Above Earth Using Asymptotic Evaluation, by D. K. Park* and J. W. Ra** (*Dept. of Elec. and Telecomm. Eng., Korea Maritime Univ., Pusan, Korea; **Dept. of Elec. Eng., KAIST, Taejon, Korea): *JKITE*, vol. 34-D, no. 1, pp. 8–13, Jan. 1997.

An electric field due to point dipole within conductor-backed thin dielectric layer above the earth is calculated by using saddle point method. When the dielectric layer is thin enough to support a cutoff mode, we show that the field may be approximated by sum of contributions of branch points of TE mode and poles of TM mode and that the branch points and poles contributions are interpreted as an evanescent lateral waves and leaky waves, respectively.

(37) Design of Broad-Band Radar Absorbing Materials Using Multilayered Lossy Dielectrics, by D. G. Lee,* G. J. Nam,** and S. S. Lee*** (*Dept. of Elec. Comm. Eng., Hanyang Univ., Seoul, Korea; **Dept. of Elec., Wonju Nat'l Jr. College, Wonju, Korea; ***School of Elec. and Electrical

Eng., Hanyang Univ., Seoul, Korea): *JKITE*, vol. 34-D, no. 3, pp. 117–124, Mar. 1997.

Broad-band RAM's (Radar Absorbing Materials) are designed by multilayered lossy dielectrics. The depth, the relative permittivity and the loss tangent of each layer are optimized in order to meet the required reflective power over the specified frequency range using a genetic algorithm. The reflection coefficients are calculated by the continued fraction method. A new population model of the partial initialization method during iterations is applied for the multimodal functions to enhance the performance of the genetic algorithm. The optimal RAM's are designed by setting the relative permittivity and the loss tangent of the dielectrics as a function of the frequency over $5 \sim 20$ GHz.

(38) Determination of the Optimum Connection Length Between Modules in the Design of Microwave Multistage Amplifiers using Amplifier Modules, by J. S. Lim and S. C. Kang (Div. of Sat. Comm., ETRI, Taejon, Korea): *JKITE*, vol. 34-D, no. 3, pp. 125–133, Mar. 1997.

In the design of microwave multistage amplifiers composed of N amplifier modules, the variation of performances of amplifier as various connection length between modules has been studied. In addition, the methods, equations and conditions for the maximum gain or the most flat gain are presented. The results of sensitivity analysis for the connection length showed that the small change in phase of input, output reflection coefficients (S_{11}, S_{22}) of module itself is the most important in determination of connection length for the most flat gain. The gain flatness of two-module amplifier of which connection length between modules had been determined by presented methods was the best one out of performances with various arbitrary connection lengths.

(39) A Study on the Transmission Efficiency of Electromagnetic Wave Propagation in Cross Type Tunnels in Time Domain, by G. R. Kim,* K. Uchida,** and K. Yasumoto*** (*Dept. of Info. and Comm., Masan Jr. College, Masan, Korea; **Dept. of Info. Eng., Fukuoka Ins. Tech., Fukuoka, Japan; ***Dept. of Info. Eng., Kyushu Univ., Kyushu, Japan): *JKITE*, vol. 34-D, no. 4, pp. 231–237, Apr. 1997.

This paper presents an analysis of the wave propagation in cross-type tunnels using the finite volume time-domain (FVTD) method. Because the FVTD method is based on the volume integrations of the Maxwell's equations with respected to arbitrary shaped small polyhedron cells and the fields at every center point of the cells are assigned in an average fashion, the method can handle arbitrary boundary problems with inhomogeneous media.

(40) Electromagnetic Wave Absorber with Wide Band Frequency Characteristics Using Exponentially Tapered Ferrite, by D. I. Kim* and S. Y. Jun** (*Dept. of Radio Sciences and Eng., Korea Maritime Univ., Pusan, Korea; **Korea Marine Train. and Res. Inst., Korea): *JKITE*, vol. 34-D, no. 4, pp. 238–246, Apr. 1997.

A wide band design method of an electromagnetic wave absorber with using exponentially tapered ferrite is proposed and discussed. A theoretical model using the equivalent material constants method is also proposed to analyze the regions varying spatially in the shape of ferrite. Based on the developed model, wide band electromagnetic wave absorbers with excellent reflectivity frequency characteristics in the frequency range of 30–2150 or 2430 MHz were designed.

(41) Three-Dimensional Simulation of Field Emitter Array, by J. H. Jung, Y. H. Kim, B. H. Lee, and J. D. Lee (School of Elec. Eng., Seoul Nat'l Univ., Seoul, Korea): *JKITE*, vol. 34-D, no. 4, pp. 330–335, Apr. 1997.

Three-dimensional finite element method (FEM) electrical field analysis was performed to obtain electric fields on a field emission display (FED) tip in an array form. Because, unlike a single tip structure, there is no azimuthal symmetry for a tip array, 3-D analysis is necessary. To reduce memory requirement the simulation was performed by applying the Neumann boundary condition to the intermediate plane between tips to take the effect of the array on the electric field into account and corresponding current was calculated. To verify our algorithm, comparison between simulation results and experimental data from another paper was made and the difference was discussed.

(42) Experiments of Bragg and Off-Bragg Blazing Phenomena by Strip Grating over a Grounded Dielectric Slab for TE Polarization Case, by W. S. Baek,* U. H. Cho,** C. H. Lee,** Y. K. Cho,** and H. Son** (*Dept. of Elec. Const. Comm. Eng., Dongyang Univ., Korea; **Dept. of Elec. Eng., Kyungpook Nat'l Univ., Taegu, Korea): *JKITE*, vol. 34-D, no. 5, pp. 351–356, May 1997.

An analysis method for the electromagnetic scattering of a TE polarized plane wave from a periodic strip grating over a grounded dielectric slab is considered from the viewpoint of reflection grating problem. The strip gratings showing Bragg and off-Bragg blazing phenomena at the frequency of 10 GHz are designed, respectively. The strip grating structure is implemented using aluminum plate (ground conductor), paraffin (dielectric material, $\epsilon_r = 2.24$) and copper (strip conductor; 0.08 mm thickness). The experimental results (reflection power) for Bragg as well as off-Bragg blazing phenomenon have compared with the theoretical results and fairly good agreements between theory and experiment have been observed.

(43) E-Polarized Electromagnetic Diffraction by a Composite Wedge, II: Extended Diffraction Coefficients, by S. Y. Kim and S. U. Kim (Div. of Elec. and Info. Tech., KIST, Seoul, Korea): *JKITE*, vol. 34-D, no. 7, pp. 507–513, July 1997.

The physical optics solution to the E-polarized diffraction by a composite wedge consisting of perfect conductor and lossless dielectric cannot satisfy not only the boundary conditions at the wedge interfaces but also the edge condition at the wedge tip. Its diffraction coefficients are extended outside the composite wedge to become the exact solution to the perfectly conducting wedge as its relative dielectric constant increases to infinite or decreases to 1. It is assured that the extended diffraction coefficients approach zero in the artificially complementary region of the composite wedge.

(44) E-Polarized Diffraction Coefficients Extended Inside Dielectric Region of a Composite Wedge, by S. Y. Kim (Div. of Elec. and Info. Tech., KIST, Seoul, Korea): *JKITE*, vol. 34-D, no. 7, pp. 514–520, July 1997.

The physical optics approximation to an E-polarized diffraction by a composite wedge provides its diffraction coefficients in terms of finite series of cotangent functions. In this paper, its diffraction coefficients inside the dielectric part are extended to become the exact solution to the perfectly conducting wedge as its relative dielectric constant increases to infinite or decreases to one. It is assured that the extended diffraction coefficients satisfy the boundary condition at the conducting interface and become zero in the artificially complementary region of the composite wedge.

(45) Calculation of the Coupling Coefficient for Trapezoidal Gratings Using the Ray Optics Technique, by S. C. Cho and B. G. Kim (Dept. of Elec. Eng., Soongsil Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 7, pp. 603–610, July 1997.

Using the ray optics technique, we derive the analytic expressions of TE mode coupling coefficient for five-layer Distributed Feedback (DFB) structure devices. We compare the coupling coefficient calculated by the ray optics technique with those calculated by the extended additional layer method (EALM) which may be a most accurate method of calculating the coupling coefficient. The difference between the results of the ray optics technique and those of the EALM is small for most cases of grating depth and forms being practically made. In the case of rectangular gratings, the difference increases as the duty cycle of grating deviates from 0.5. In the case of the trapezoidal grating, the difference increases as the ratio of the top to the period of grating deviates from 0.5 and as the length of the top becomes longer than that of the base. The difference of three-layer DFB structures is smaller than that of five-layer DFB structures.

(46) Interrelationship of Phase-Error Variance and Correlation Coefficient in Microwave Imaging, by B. S. Kang* and H. G. Yang** (*Div. of System LSI, Samsung Elec. Co. Ltd., Korea; **Dept. of Radio Science and Eng., Inst. of New Tech., Kwangwoon Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 10, pp. 777–783, Oct. 1997.

This paper presents the theoretical derivation relating an image correlation coefficient capable of assessing image quality, with phase-error variance in antenna aperture domain. We show that when the phase-error variance of a range bin selected as an adaptive beam former is known, the quality of the reconstructed image is predictable and moreover, the resultant correlation coefficient is obviously greater than the derived lower bound. To support the derivation, real data are used for image formation where the dominant scatterer algorithm (DSA) is applied for phase compensation.

(47) Characteristic Mode Analysis for the Finite Slotted Parallel-Plate Waveguide as a Leaky Wave Antenna Structure, by L. H. Yun and Y. K. Cho (School of Elec. and Electric Eng., Kyungpook Nat'l Univ., Taegu, Korea): *JKITE,* vol. 34-D, no. 10, pp. 808–814, Oct. 1997.

A characteristic mode analysis of parallel-plate waveguide with finite number of slots as a leaky wave antenna structure is considered for calculating the characteristic currents, the characteristic patterns, radiation patterns, and the complex propagation constants. For the cases of 1, 11, and 29 slots, numerical results for the equivalent magnetic currents, the radiation patterns, and the complex propagation constants are computed and compared with those obtained by use of the conventional method of moments. Good correspondence between them is observed.

(48) Diffraction of Gaussian Beam Wave by Finite Periodic Slots in the Upper Plate of a Parallel-Plate Waveguide, by J. I. Lee and Y. K. Cho (School of Elec. and Electrical Eng., Kyungpook Nat'l Univ., Taegu, Korea): *JKITE,* vol. 34-D, no. 10, pp. 815–820, Oct. 1997.

An analysis method for the electromagnetic scattering of a Gaussian beam wave by finite grating structure of the slots in the upper plate of the parallel-plate waveguide (PPW) is considered. The integral-differential equation for the unknown equivalent magnetic current over the slots is derived and solved numerically by use of the method of moment of the Galerkin's scheme. From knowledge of the slot magnetic current, the quantities of interest such as the scattering behavior in the free space, the space wave power radiated into the free space, and the coupled wave power through the slots into the PPW are computed for the appropriately chosen parameters. Some similarity between scattering behaviors of the present geometry and the rectangular groove geometry is examined and the off-Bragg as well as Bragg blazing phenomena in the infinite geometry are observed in the proposed finite geometry. The validity of the numerical results are assured by a check of the power conservation relation.

(49) Diffraction of Gaussian Beam Wave by Finite Periodic Conducting Strip Grating on a Grounded Dielectric Slab, by J. L Lee and Y. K. Cho (School of Elec. and Electrical Eng., Kyungpook Nat'l Univ., Taegu, Korea): *JKITE,* vol. 34-D, no. 10, pp. 821–828, Oct. 1997.

On analysis method for the electromagnetic scattering of a Gaussian beam wave by finite periodic conducting strip grating on a grounded dielectric slab is considered. The integral equation for the unknown current induced on the conducting strip surface is derived and solved numerically by use of the method of moment. From knowledge of the strip current, the quantities of interest such as radiation pattern, the space wave power radiated into the free space, and the coupled surface wave power propagating along the dielectric slab are computed for the appropriately chosen parameters. Some similarity between scattering behaviors of the present geometry and the infinite geometry is examined by observing the off-Bragg as well as Bragg blazing phenomena in both geometries. The validity of the numerical results are assured by a check of the power conservation relation.

(50) Radio Wave Propagation Simulations of Indoor by Finite Difference Time Domain Method, by M. M. Hur,* R. J. Peak,** H. H. Bahk,*** and H. B. Yoon* (*Dept. of Elec. Eng., Donguk Univ., Seoul, Korea; **ACE Tech. Co. Ltd., Korea; ***ETRI, Taejon, Korea): *JKITE,* vol. 34-D, no. 10, pp. 836–844, Oct. 1997.

This paper presents a 3-D finite-difference time-domain (FDTD) method used for indoor propagation simulations where the electromagnetic wave is uniformly excited on the one of the wall in a building and affected by an indoor obstacles. In cases of simulation and measurement, the frequency of 851 MHz is used. The conductivities

of walls, floor, ceiling and indoor obstacles are measured and used for simulations. These simulations are carried out using different boundary condition such as Mur's absorbing boundary condition (ABC) and perfectly matched layer (PML) technique. The PML technique is found to be well-suited to this analysis because of it's smaller computational domain than Mur's ABC. The measured signal strengths are compared to simulated values with good agreement.

(51) The Reflection and Transmission Characteristics of Radio Wave at a Building Construction Site Due to Reinforced Concrete Slabs, by H. Chiba and Y. Miyazaki (Toyohashi University of Technology, Toyohashi-shi, 441 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 110–120, Jan. 1997.

The RC slab at a building construction site has various shapes during its construction. Each shape has its own characteristics for radiowave propagation. It is very important to know these characteristics for effective use of wireless communication systems for site workers. Here we formulate a model to determine the characteristics. First, we analyze the reflection and transmission characteristics of reinforcing bar mesh and the dependence of complex permittivity on the frequency and the water content of concrete. Second, simple RC slabs are modeled as multiple stratification and analyzed these characteristics with numerical and experimental.

(52) The FDTD Analysis on Reflection Characteristics of Metal Plate Which Is Smaller than Lambda, by O. Hashimoto and S. Nishizawa (College of Science and Engineering, Aoyama Gakuin University Tokyo, 157 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 121–122, Jan. 1997.

In this paper, we calculated the reflection characteristics of metal plate that is smaller than 1 lambda with the FDTD Method. The results are compared with the boundary element method (BEM) and confirmed the validity of the FDTD for the electromagnetic scattering problem, and we furnished the standard data of the reflection characteristics from metal plate that is going to used for reflection measurement from a wave absorber.

(53) A General Construction Method of Dyadic Green's Functions for Plane-Stratified Media in Uniform Open or Closed Waveguide of Separable Cross-Sections, by Y. Yamaguchi,* H. Miyashita,* I. Chiba,* and S. Egashira** (*Mitsubishi Electric Corporation, Kamakura-shi, 247 Japan; **Faculty of Science and Engineering, Saga University, Saga-shi, 840 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 406–415, May. 1997.

In this paper a construction method of Dyadic Green's functions has been described for plane-stratified media in open or closed waveguide of separable cross-sections. The developed method of Barkeshli and Pathak about a construction of plane-wave spectrum representation of a Dyadic Green's function for multilayered media has been modified so as to employ the method of Felsen and Marcuvitz to develop a fairly general expression which recovers the result of Barkeshli and Pathak when the plane-wave spectrum representation is used for the transverse waveguide mode functions. The results have been shown when the rectangular and circular waveguide mode functions are used as the transverse waveguide mode functions. A high-frequency asymptotic analysis of Dyadic Green's function has been demonstrated which allows a simple four-ray interpretation of wave propagation in plane-stratified media.

(54) A Deghosting Algorithm Using the Cross-Correlations in Triangulate Positioning Systems, by A. Okamura and S. Mano (Information Technology R&D Center, Mitsubishi Electric Corporation, Kamakura-shi, 247 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 507–515, June 1997.

It is known that a source position can be determined by using the triangulation method and bearing data detected in passive sensor system. In the case of the multiple sources, however, some ghosts occur form some combination of bearings. In this paper, we propose a new deghosting algorithm which uses the cross-correlations between signals received by each sensor. The combination of bearings which gives the true source position is chosen by utilizing the order of cross-correlation at each sensor. The cross-correlations can be calculated easily as MUSIC super-resolution algorithm is used to estimate the bearings. Computer simulations have also shown the effectiveness of the proposed algorithm.

(55) Radome Effect on the Miss Distance of a Radar Homing System, by S. Miwa (Department of Information and Communication systems, Tokyo Denki University, 2-2 Kanda Nishiki-cho, Chiyoda-ku, Tokyo 101 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 516–523, June 1997.

Miss distances due to the radome are analyzed applying the nonlinear covariance analysis method on the fifth-order missile model. The difference of the fifth-order model over the third-order one is shown first, then the miss distance versus radome error slope characteristics for various parameters are described based on the assumption that the radome error slope is constant during the flight. The slope is, however, considered to change sinusoidally during flight according to the factory measured value and the flight simulation. This effect on the miss distance is evaluated on the last part of the paper.

(56) An Analysis Charged Floor Potential Using Electromagnetic Field Theory, by O. Fujiwara, K. Nakazawa, and H. Takeshita (Faculty of Engineering Nagoya Institute of Technology, Nagoya-shi, 466 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 784–790, Sept. 1997.

As an effective measure against the electrostatic discharge causing serious failures for the high-tech information equipment, it is widely accepted that floor material with low resistance is used to reduce a charged body potential on the floor, while the attenuation process is not being well elucidated. We have previously proposed a two-dimensional equivalent circuit model for predicting the potential attenuation characteristics of the human body charged on the floor, where *a priori* we introduced an imaginary capacitance between the insulating floor material and the conducting reinforced concrete. We therefore analyze a charged floor potential using an electromagnetic field theory in order to theoretically justify the result derived from the circuit model approach. An electrification experiment is also conducted for validating the analyzed results.

(57) Analysis of Electromagnetic Field Coupled Through an Aperture of Equipment Housing, by H. Kogure, H. Nakano, K. Koshiji, and E. Shu (Faculty of Science and Tech-

nology, Science University of Tokyo, Noda-shi, 278 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 809–811, Sept. 1997.

Electromagnetic field distribution inside equipment housing with an aperture excited by a plane wave was analyzed using electromagnetic field analysis by the transmission-line modeling method. Highly coupled frequency inside housing was predicted only by a structure of housing and the analyzed results gave a good agreement with measured data.

(58) An Analysis of Beam Deflection Characteristics of Offset Parabolic Antennas by Beam Mode Expansion, by N. Miyahara,* S. Makino,* S. Urasaki,* and S. Betsudan** (*Mitsubishi Electric Corporation, Kamakura-shi, 247 Japan; **Mitsubishi Electric Corporation, Amagasaki-shi, 661 Japan): *Trans. IEICE,* vol. J80-B-II, pp. 953–962, Nov. 1997.

On parabolic antennas with a displaced feed, aberration on the aperture causes degradation of radiation characteristics. In this paper, the aberration on the aperture is derived by a beam mode expansion method. The amount of aberration is expressed in a simple form taking account of fundamental beam mode. Using this aberration, formulation of estimating beam deflection characteristics is derived based on the aperture distribution method. As for gain losses, simple formula in a closed form is derived in condition that the F/D ratio and the edge level are small. The validity of the analysis method was confirmed by comparing between presented method and rigid results which is calculated by the current distribution method.

(59) New Distributed Implementation of the FDTD Method, by N. Takeda,* K. Ando,** K. Tomojima,*** T. Ito,*** and S. Kozaki*** (*Department of Electronic Control Engineering, Oyama National College of Technology, Oyarna-shi, 323 Japan; **Japan Radio Co., Ltd., Mitaka-shi, 181 Japan; ***Faculty of Engineering, Gunma University, Kiryu-shi, 376 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 47–54, Feb. 1997.

FDTD is a very flexible and powerful approach for electromagnetic field analysis. However the method requires large computer memory space and long computation time for three-dimensional and large-scale two-dimensional problems, restricting its use on sequential computers to small problems. Recently, Rodohan established the distributed FDTD method to overcome these problems. This method is the improved FDTD method for computing in parallel based on distributed-memory computer architectures. In this paper we first propose the new distributed FDTD method algorithm with improved third-order absorbing boundary conditions. The communication number costs of our method halves from those of Rodohan method. Finally, we conclusion that the time simulating by our method is shorter.

(60) Electromagnetic Plane Wave Scattering by a Gap on a Ground Plane, by R. Sato and H. Shirai (Graduate School of Science and Engineering, Chuo University, Tokyo, 112 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 179–185, May 1997.

Electromagnetic plane wave scattering by a gap on a ground plane has been analyzed. First, a rectangular trough is considered as the model of the gap to obtain the rigorous representation of the scattering field based on Kobayashi and Nomura's method. Then the simple formulas for electrically narrow aperture have been derived. Numerical calculation has been done to check the validity of the derived formulas for various gap's width and depth. It is shown that their numerical results are in good agreement with those obtained from the rigorous representation, when the gap's width is less than 0.2 wavelength for both H and E polarizations, regardless of the depth. Comparison with other approximated solutions for narrow case is also discussed.

(61) Finite Element Beam Propagation Method for Anisotropic Optical Waveguides, by N. Takimoto,* M. Koshiba,* and Y. Tsuji** (*Faculty of Engineering, Hokkaido University, Sapporo-shi, 060 Japan; **Hokkaido Institute of Technology, Sapporo-shi, 060 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 213–219, May 1997.

A finite-element beam propagation method for the analysis of anisotropic optical waveguides with arbitrary permittivity tensor is described. In present algorithm, Padé approximation operator for wide-angle propagation, transparent boundary condition avoiding spurious reflections from computational window edges, adaptive reference refractive index, and adaptive grid are effectively utilized. In order to show the validity of this approach, numerical examples are shown for a tilted anisotropic waveguide and an S-shaped anisotropic waveguide bend.

(62) Finite Element Beam-Propagation Method for Three-Dimensional Optical Waveguide Structures, by Y. Tsuji,* M. Koshiba,** and T. Shiraishi** (*Department of Applied Electronics, Hokkaido Institute of Technology, Sapporo-shi, 060 Japan; **Division of Electronics and information Engineering, Hokkaido University, Sapporo-shi, 060 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 220–226, May 1997.

A unified finite element beam propagation method is described for both quasi-TE and quasi-TM modes propagating in 3-D optical waveguides. In order to avoid nonphysical reflections from the computational window edges, the transparent boundary condition is introduced for both polarizations. The present algorithm using the Padé, approximation is, to our knowledge, the first wide-angle finite element beam propagation method for 3-D waveguide structures. To show the validity and usefulness of this approach, numerical results are shown for Gaussian beam propagation in free space and quasi-TE mode propagation in a Y-junction.

(63) Combined Beam Propagation and Bidirectional Eigenmode Propagation Methods for Bidirectional Optical Beam Propagation Analysis, by K. Hayashi, and M. Koshiba (Faculty of Engineering, Hokkaido University, Sapporo-shi, 060 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 227–234, May 1997.

A combined method of the beam propagation method (BPM) and the bidirectional Eigenmode propagation method (BEP) is proposed for the analysis of reflections in wave guiding structures containing longitudinal discontinuities. The BPM based on the finite-element method (FEM) is applied to slowly varying regions and the BEP is applied only to regions including abrupt discontinuities. The FEM is also utilized for evaluating the Eigenmode necessary in the BEP analysis. To show the validity and usefulness of the approach proposed

here, numerical examples for a semiconductor laser facet, an optical waveguide connection, and an optical directional coupler are presented.

(64) Single Mode Transmission and Backward Wave Properties of Optical and Extremely High Frequency Electromagnetic Waves in a Three Stratified Plane Metal Waveguide, by S. Nonaka (Toyota Technological Institute, Faculty of Engineering, 2-12-1 Hisakata, Tenpaku-ku, Nagoya-shi, 468 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 235–242, May 1997.

For planar integrated circuits, the conditions for single-mode and backward wave propagations of optical and extremely high frequency electromagnetic waves propagating along a three stratified plane-metal waveguide (strip lines) are obtained analytically under a half-wavelength cutoff condition for the lowest four normal modes. The solutions are obtained on the basis of electron plasma frequency in metals. The results obtained under the cutoff condition are summarized as follows : 1) the conditions for individual single mode propagation of SW° (odd surface wave), SW_e (even surface wave), TM_1^e and TE_1° are specified definitely; 2) SW° and TE_1° modes always exhibit forward wave properties, so that these modes are utilizable for individual single mode transmission between the strip lines; 3) SW^e and TM_1^e modes exhibit backward wave properties under a special condition; and 4) the backward SW^e and TM_1^e modes are utilized, along with a light-house tube, to explain a well known "optical light emissions from a metal-wide-metal tunnel junction structure."

(65) FDTD Analysis of Time Domain Inverse Scattering Problem for Stratified Media, by T. Takenaka,* H. Harada,** and T. Tanaka* (*Faculty of Engineering, Nagasaki University, Nagasaki-shi, 852 Japan; **Kagoshima National College of Technology, Kagoshima-ken, 899-51 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 246–247, May 1997.

In this letter, we present a time-domain iterative algorithm using FDTD method for reconstruction of electrical parameters of a lossless inhomogeneous stratified medium from reflection data. The simulated results for a lossless dielectric slab demonstrate the property of high-quality reconstruction.

(66) A Modification of FDTD Formulas at Conductor Edge Singularities, by T. Shibata* and T. Itoh** (*NTT System Electronics Laboratories, Atsugi-shi, 243-01 Japan; **E. E. Department, UCLA, Los Angeles, CA, USA): *Trans. IEICE,* vol. J80-C-I, pp. 248–249, May 1997.

The finite-difference time-domain (FDTD) method is well acknowledged as a powerful means of electromagnetic field simulations. This paper presents a modification of the FDTD formulas at conductor edge singularities to compensate for the numerical error caused from the grid coarseness. Dramatic improvement in numerical precision and/or computational efficiency has been obtained.

(67) Implementation of Improved PML in the FD-TD Analysis of Infinitely Periodic Array, by S. Abe,* N. Takada,** Y. Sugano,* and S. Kozaki* (*Faculty of Engineering, Gunma University, Kiryu-shi, 376 Japan; **Department of Electronic Control Engineering, Oyama National College of Technology, Oyama-shi, 323 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 294–295, June 1997.

Infinite periodic scattering problems are analyzed by using FD-TD method, with the PML used to terminate the computational domain. PML needs the sufficient thickness of the matched layers to get small reflection. New PML is presented that improved to evaluate the field component at the end of the grid. Numerical tests show that it has small reflection errors than PML and other ABC.

(68) Degree of Polarization of Plane Waves in Absorbing Media, by S. Tokumaru (Faculty of Science and Technology, Keio University, Yokohama-shi, 223 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 305–312, July 1997.

There is no theoretical discussion on partially polarized plane waves in absorbing media. In this paper several definitions of the degree of polarization are newly proposed in the absorbing media, by the assumption that a turbulent field is approximately described only as a complex amplitude variation of an incoming complex plane wave, and furthermore, by the aid of measured six electromagnetic energy parameters including the normalized pointing flux. These energy parameters are measured in the similar manner as the Stokes parameters by a probing system composed of a small dipole and a small loop antennas. A partially polarized field is decomposed into the polarized and the unpolarized fields which show vectorial properties.

(69) Availability of Resistive Boundary Conditions for Plane Gratings, by H. Wakabayashi,* J. Yamakita,* K. Matsumoto,** and M. Asai*** (*Faculty of Computer Science and System Engineering, Okayama Prefectural University, Soja-shi, 719-11 Japan; **Faculty of Engineering, Osaka Sangyo University, Daito-shi, 574 Japan; ***Faculty of Biology-Oriented Science and Technology, Kinki University, Wakayama-ken, 649-64 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 387–396, Sept. 1997.

The spectral-Galerkin procedure is often used for analyzing scattering by metallic gratings. Resistive boundary condition is applied to some metallic gratings which are assumed zero-thickness plane gratings. However, it is difficult to simulate the resistive plane gratings without knowing the limits of thickness in applicability of such boundary condition. In this report, the relations between plane metallic gratings and thin dielectric gratings of complex dielectric constants are investigated by using the conventional methods for dielectric gratings. From numerical results, availability of resistive boundary condition is discussed.

(70) A Finite-Difference Vector Beam Propagation Method for Isotropic Open Chiral Slab Waveguide, by T. Yabu and S. Sawa (Faculty of Engineering, Osaka Prefecture University, Sakai-shi, 593 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 397–406, Sept. 1997.

In this paper, we present a formulation of finite-difference vector beam propagation method for an isotropic open Chiral slab waveguide. This method enables the analysis of wave propagation on the Chiral slab waveguide which varies along the light propagating direction. Numerical results show that the proposed method works successfully. Using this method, very interesting phenomena of mode conversion on the Chiral slab waveguide are analyzed.

(71) The Method of Matrix-Order Reduction and Its Applications to Electromagnetic Problems, by W. Cao,* N. Inagaki,** and D. Wu* (*Department of Radio Engineering, Nanjing University of Posts and Telecommunications, Nanjing 210003, P.R. China; **Department of Electrical and Computer Engineering, Nagoya Institute of Technology, Nagoya-shi, 466 Japan): *IEICE Trans. Cornmun.,* vol. E80-13, pp. 608–616, Apr. 1997.

A new numerical technique, termed the method of matrix-order reduction (MMOR), is developed for handling electromagnetic problems in this paper, in which the matrix equation resulted from a method-of-moments analysis is converted either to an eigenvalue equation or to another matrix equation with the matrix order in both cases being much reduced, and also, the accuracy of solution obtained by solving either of above equations is improved by means of a newly proposed generalized Jacobian iteration. As a result, this technique enjoys the advantages of less computational expenses and a relatively good solution accuracy as well. To testify this new technique, a number of wire antennas are examined and the calculated results are compared with those obtained by using the method of moments.

(72) Microwave Propagation in Dust Storms at 10.5 GHz—A Case Study in Khartoum, Sudan, by S. I Ghobrial* and J. A. Jervase** (*Professor of Electrical Engineering, University of Khartoum. Present address: P.O. Box 1590, Khartoum, Sudan;**Electrical& Electronic Engineering Dept., College of Engineering, Sultan Qaboos University, P.O. Box 33, Muscat, Oman 123): *IEICE Trans. Commun.,* vol. E80-B, pp. 1722–1727, Nov. 1997.

Observations on a 25-km microwave study link operating at 10.5 GHz revealed that the attenuation caused by dust storms agrees very well with theoretical predictions. During an extremely dense storm, at the peak of which visibility dropped to less than 5 m, the maximum attenuation observed was less than 7 dB. The computed value lies between 3.8–10.2 dB. The uncertainty is due to lack of information on the exact visibility during the storm. The effect of dust particles precipitation is found to reduce attenuation in an exponential manner. An analysis based on particles size distribution and their terminal velocity in air is developed to explain the observed exponential decay.

(73) Estimating One- and Two-Dimensional Direction of Arrival in an Incoherent/Coherent Source Environment, by A. Medouri,* A. Gallego,** D. P. Ruiz,** and M. C. Carrion** (*Centre National de Coordination et de Planification de la Recherche Scientifique et Technique, Laboratoire de Geophysique, CNCPRST B. P. 8027, Rabat, Morocco; **Department of Applied Physics, Faculty of Science, University of Granada, 18071, Granada, Spain): *IEICE Trans. Commun.,* vol. E80-B, pp. 1728–1740, Nov. 1997.

We consider the problem of estimating one- and two-dimensional direction of arrivals for arbitrary plane waves in an incoherent/coherent source environment. For the one-dimensional case, we use matrix pencil (MP) method developed by Hua for signal-poles estimation. We then extend this method to estimate the two-dimensional direction of arrivals (2D-DOA), resulting in the "extended matrix pencil" (EMP) method. This method can be applied successfully as much for an incoherent source environment as for a coherent source environment. To study the performance of these methods, in both cases results are compared with the "total least squares-estimation of signal parameters via rotational invariance techniques" (TLS-ESPRIT) and the "spatial smoothing-TLS-ESPRIT" (SS-TLS-ESPRIT) methods. The results show that the MP method estimates the DOA more accurately and better than the TLS-ESPRIT and the SS-TLS-ESPRIT, even with few snap-shots. Simulation results show that the EMP method, presented in this paper, estimates the 2-DOA better than the other two methods used for comparison.

(74) On the Applicability of a Boundary Matching Technique to the Reconstruction of Circularly Symmetric Cylinders from Scattered H-Wave, by K. Ishida, and M. Tateiba (Graduate School of Information Science and Electrical Engineering, Kyushu University, Fukuoka-shi, 812-81 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 503–507, Mar. 1997.

The applicability of a boundary matching technique is presented for reconstructing the refractive-index profile of a circularly symmetric cylinder from the measurement of the scattered wave when the cylinder is illuminated by an H-polarized plane wave. The algorithm of reconstruction is based on an iterative procedure of matching the scattered wave calculated from a certain refractive-index distribution with the measured scattered-wave. The limits of reconstruction for strongly inhomogeneous lossless and lossy cylinders are numerically shown through computer simulations under noisy environment, and are compared with those in the E-wave case.

(75) A Uniform Asymptotic Expression for the Function Arising in the Wedge Scattering Problem, by M. Kodama, H. Takahashi, and K. Taira (Faculty of Engineering, University of the Ryukyus, Okinawa-ken, 903-01 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 831–833, June 1997.

Scattering of a plane electromagnetic wave by a conducting wedge will be discussed. The former solution can not be applicable to all the transition regions when its parameter is constant. This study shows a new solution which consists of only one expression applicable to the shadow region, the illuminated region and the transition regions, and which has no parameter.

(76) Uniform Physical Optics Diffraction Coefficients for Impedance Surfaces and Apertures, by M. Oodo and M. Ando (Department of Electrical and Electronic Engineering, Faculty of Engineering, Tokyo Institute of Technology, 2-12-1, O-Okayama, Meguro-ku, Tokyo, 152 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 1056–1062, July 1997.

The key concept of physical optics (PO), originally developed for a perfectly electric conductor (PEC), consists in that the high frequency fields on the scatterer surface are approximated by those which would exist on the infinite flat surface tangent to the scatterer. The scattered fields at arbitrary observation points are then calculated by integrating these fields on the scatterer. This general concept can be extended to arbitrary impedance surfaces. The asymptotic evaluation of this surface integration in terms of diffraction coefficients gives us the fields in analytical forms. In this paper, uniform

PO diffraction coefficients for the impedance surfaces are presented and their high accuracy is verified numerically. These coefficients are providing us with the tool for the mechanism extraction of various high frequency methods such as aperture field integration method and Kirchhoff's method.

(77) Analysis and Elimination of the Reflection Influence on Microwave Attenuation Measurement for Moisture Determination, by Z. Ma and S. Okamura (Department of Electrical and Electronic Engineering, Shizuoka University, Hamamatsushi 432 Japan): *IEICE Trans. Electron.*, vol. E80-C, pp. 1324–1329, Oct. 1997.

An analysis is carried out about the reflection influence on the microwave attenuation measurement for moisture content determination. A new method taking into account the reflection influence is proposed and it is proved valid by the experiment results. Using this method, the density dependence of the attenuation is measured and the measured data can be fitted well by a straight line passing through the origin. Therefore, the attenuation per unit density and propagation distance is a function which depends only on the moisture content and the function is useful to the determination of the moisture content.

V. Microwave Medical/Biological Applications

(1) Effect of Human Body on the Radiation Characteristic of Mobile Communication Handset Antenna, by G. Kang, X.-L. Zhu, C.-Q. Wang, and C.-H. Xu (Peking University, Beijing, P.R.C.): *AES*, vol. 25, no. 9, pp. 51–55, Sept. 1997.

Using FDTD method and heterogeneous model of human body, this paper correctly simulates the radiation characteristic of the handset antenna normally used in mobile communication system. Especially, the interaction between the antenna and human body is studied in detail. As a result, the radiation pattern and efficiency of the antenna are given.

(2) Study of Mechanism of the Bioeffects of Transient or Impulse Electromagnetic Fields, by B.-Y. Wang,* R.-M. Xu,* J.-B. Yang,* C.-J. Liu,* Q.-G. Guo,* Z.-S. Wang,** F.-D. Zou,** Y.-J. Wang,** H.-Y. Hou,** and D.-B. Wang** (*Dept. of Radio-Electronics, Sichuan Union University, Chengdu, P.R.C.; **Dept. of Biology, Sichuan Union University, Chengdu, P.R.C.): *AES*, vol. 25, no. 3, pp. 37–40, Mar. 1997.

The athermal biological effect of transient EM fields was studied systematically by using the broad-band transverse electromagnetic wave cell in the experiment of biological cells. The preliminary interactive mechanism was presented also.

(3) The Influence of Blood Flow on the Effective Hyperthermic Temperature Distribution and Its Compensation Method, by P. He, S.-J. Wang, X.-W. Sui, L.-R. Zhang, and W.-C. Xiang (Tianjin University, Tianjin, P. R. C.): *JM*, vol. 13, no. 3, pp. 255–263, Sept. 1997.

The influence of blood flow on the effective hyperthermic temperature distribution is analyzed with an example of water-cooled insulated dipole microwave applicator for intracavitary hyperthermic. Then, the methods of recognition of blood flow and its compensation are proposed. It is of importance to the increase of clinical hyperthermic curative effects.

(4) Development of Biological Signal Optical Transmission System, by J. D. Park,* J. W. Sohn,* and H. D. Seo** (*ETRJ, Taejon, Korea; **Dept. of Elec. Eng., Yeungnam Univ., Taegu, Korea): *JKICS*, vol. 22, no. 9, pp. 1933–1940, Sept. 1997.

The development of CMOS IC chip and external system with optical transmission system is proposed in this paper, which deal with 4 subject 4 channel biological signals, receive and transmit biological signals to the external system using LED and infrared light of photo diode. This system decreases the dependency of power supply voltage to the CMOS IC chip. A new enforced synchronization technique using infrared bidirectional communication has been proposed. The telemetry IC with the size of 5.1×5.1 mm^2 has the following functions: receiving of command signal, initialization of internal state of all functional blocks, decoding of subject selection signal, time division multiplexing of four-channel modulated biological signals, transmission of modulated signals to external system, and auto power down control. To confirm the total telemetry system, electrocardiogram is transmitted and received to the external system using optical link.

VI. Lasers and Other Devices

(1) An Analysis of Phase-Shift in Erbium-Doped Fiber Amplifier, by H.-J. He, W.-Y. Gu, G.-R. Li, and D.-X. Xu (Beijing University of posts& Telecommunications, Beijing, P.R.C.): *JCIC*, vol. 18, no. 1, pp. 92–95, Jan. 1997.

The phase-shift in erbium-doped fiber is analyzed by calculating the real part of the susceptibility in it, and we find out that the ratio of additional phase-shift introduced by E_r^{3+} ion radiation to inherent phase-shift of optical fiber is about 10^{-6}, which is greater than that of other nonlinear effects in fiber. It is showed that the additional chromatic dispersion in the wavelength range of 1.53–1.59 μm varies from positive into negative along with the increase of pump power.

(2) Laser Phase Noise Influence on the Performance of High Speed IM/DD Optical Fiber Communication System, by Y.-J. Chai, Z.-X. Yang, H. Yang, and C.-C. Fan (Tsinghua University, Beijing, P.R.C.): *JCIC*, vol. 18, no. 17, pp. 1–5, July 1997.

The influence of laser phase noise is evaluated. The result shows that laser phase noise must be considered in designing high speed optical fiber system, because of the fiber dispersion, laser phase noise can be converted to intensity noise at the receiver, and deteriorates the receiver sensitivity.

(3) External Electro-Optic Sampling System with a 1.3 μm Gain-Switched DFB Laser Diode, by Y.-C. Wang, X.-H. Wang, and G.-F. Chen (State Key Lab. of Transient Optics Technology, Xi'an Institute of Optics& Fine Mechanics, Chinese Academy of Sciences, Xi'an, P.R.C.): *JIMW*, vol. 16, no. 6, pp. 401–405, Dec. 1997.

An external electro-optic sampling system using a $L_iT_aO_3$ tip with a gain-switched DFB laser diode was described. The 1.3-μm ultra-short optic pulses were used to perform electric pulse via the Pockels effect in $L_iT_aO_3$ tip. The response curve of a high-speed detector and the propagation dispersion of a coplanar strips were measured by this system.

(4) Circuit Model for Distributed Feedback Semiconductor Lasers, by W.-Y. Chen and S.-Y. Liu (Jilin University, Changchun, P.R.C.): *JE,* vol. 19, no. 5, pp. 658–664, Sept. 1997.

This paper presents a sample circuit model for no internal phase shift and single longitudinal mode DFB-LD, basing on the coupling wave equations for period waveguide structure and the rate equation for carrier density. The simulated results from this model are agree with the reports in the literature.

(5) Silicon Oxide and Poly-Si Film Simultaneously Formed by Excimer Laser, by C. M. Park,* B. H. Min,* J. H. Jun,* J. S. Yoo,* H. S. Choi,* and M. K. Han* (*School of Elec. Eng., Seoul Nat'l Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 1, pp. 35–40, Jan. 1997.

A new method to form the gate oxide and recrystallize the polycrystalline silicon (poly-Si) active layer simultaneously is proposed and fabricated successfully. During the irradiation of Excimer laser, the poly-Si film is recrystallized, while the oxygen ion impurities injected into the amorphous silicon (a-Si) film are activated by laser energy and react with silicon atoms to form SiO_2. We investigated the characteristics of the sample fabricated by proposed method using AES, TEM, AFM. The electrical performance of oxide was verified by ramp up voltage method. Our experimental results show that a high quality oxide, a poly-Si film with fine grain, and a smooth and clean interface between oxide and poly-Si film have been successfully obtained by the proposed fabrication method. The interface roughness of oxide/poly-Si fabricated by new method is superior to film by conventional fabrication so that the proposed method may improve the performance of poly-Si TFT's.

(6) Design Rules of Directional Coupler Optical Switches in Consideration of Parasitic Couplings in the Input/Output Bending Sections, by D. G. Kim and C. M. Kim (Dept. of Elec. Eng., Seoul City Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 1, pp. 41–48, Jan. 1997.

Design rules of directional coupler optical switches are discussed in consideration of parasitic couplings in the bending sections. The parasitic coupling phenomenon is analyzed based on the coupled-mode theory and the solutions are represented in the form of the transfer matrix. The modified switching conditions due to the parasitic coupling are derived and the resultant switching diagrams are illustrated. It is revealed that the parallel section's length needs to be adjusted less than the coupling length $l_c(=\pi/2\kappa_o)$ to obtain the desired cross talk and that the adjustment depends on the strength of the parasitic coupling. However, it is discovered that, for weak parasitic coupling, the switching voltage does not need to be altered but may maintain the same value as if no parasitic coupling is taken into account.

(7) An Effective Parallel Optical Interconnection Using Single GRIN Rod Lens, by S. C. Kim,* W. Lee,* B. H. Lee,* and J. C. Jeong** (*School of Elec. Eng., Seoul Nat'l Univ., Seoul, Korea; **Dept. of Radio Eng., Korea Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 1, pp. 49–54, Jan. 1997.

We proved the feasibility of a parallel optical interconnection technique using single GRIN (graded-index) rod lens as an intermediate coupling device, which increases the working distance and makes packaging easy. The proposed technique shows relatively less dependency on misalignments. In this paper, for convenience of experiments, we applied this method to four-channel coupling between two fiber arrays, and compared it with butt-coupling and the method of using ball lens. The comparison shows the feasibility of adopting the proposed method to the parallel interconnection between a laser diode array and an optical fiber array.

(8) Implementation of Automatic Gain Control Circuit for the Gain Control of Receiving Stage in Pulse Doppler Radar, by S. Y. Kim, J. M. Kim, and B. T. Jeon (ADD, Taejon, Korea): *JKITE,* vol. 34-D, no. 2, pp. 64–74, Feb. 1997.

This paper describes the design, the manufacture and the development automatic gain control unit which adjusts the gain of IF processor in the high multifunctional receiver unit (HMR) for pulse Doppler radar system. According to the effective distance of target, radar cross section, and a lot of external environment (such as Clutter), the receiving stage of RADAR system often deviates from dynamic range. To solve this kind of problem, continuous/pulse wave AGC are realized, making it possible to control the gain characteristics of receiver stably, and can increase dynamic range linearly by adjusting the gain slope of receiver which is limited by 1-dB gain compression point. In this study, AGC unit is designed to regulate the total gain of receiver by using the analog feedback theory. It also has rapid enough response to process pulse signal. This study presents the gain control method of IF, the real manufacture technique (the package-type components), and the measurement performance of AGC.

(9) Design of Optical Power Splitters and Couplers Composed of Deeply Etched Multimode Interference Section, by J. W. Kim and Y. C. Chung (Dept. of Elec. Comm. Eng., School of Elec. Eng. The Ins. of New Tech., Kwangwoon Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 4, pp. 292–302, Apr. 1997.

The optical power splitter/couplers based on MMI (multimode interference) in GaAs/AlGaAs are studied. We present a design of optical power splitter/couplers, which have deeply etched multimode waveguide. The properties and fabrication tolerance on the etching depth, multimode waveguide width are simulated using a FD-BPM (finite-difference beam propagation method). Proposed $1\times N$ optical power splitters exhibit excess loss of 0.2 dB and uniformity of 0.2 dB. It is found that the excess loss of designed device is 0.7 dB smaller than the optical power splitter with a shallowly etched MMI section. For 0.5-dB excess loss, the predicted fabrication tolerance is 0.6 μm on the multimode waveguide width of the 14 optical power splitter with a deeply etched MMI section. Also excess loss and uniformity of proposed 32 $\times$ 32 optical power coupler are below 0.3 dB. The excess loss of proposed 32 $\times$ 32 optical power coupler is 2 dB smaller than the optical power coupler with a shallowly etched MMI section. It is shown that the optical power splitters/couplers with a deeply etched MMI section have low loss, good uniformity, and improved fabrication tolerance.

(10) Fabrication of Integrated Optical Waveguide Polarizer by Utilizing the Birefringence Induced by Photo Bleaching in an Electro-Optic Polymer, by S. W. Ahn, S.

S. Lee, and S. Y. Shin (Dept. of Elec. Eng., KAIST, Taejon, Korea): *JKITE*, vol. 34-D, no. 4, pp. 303–308, Apr. 1997.

A polymeric waveguide TE-pass polarizer operating at wavelengths around 1.55 μm is realized by utilizing the Birefringence induced by photo bleaching at room temperature. To implement the polarizer, the photo bleached waveguide supporting only TE mode is integrated in the middle of the etched rib waveguide that supports TE and TM modes. It has a simple structure and requires no high-temperature process like poling. The measured polarization extinction ratio is about 21 dB and the estimated excess loss is about 0.4 dB.

(11) Analysis of Electro-Optic Polymer Digital Optical Switch with a Coupling Region Modified for Optimum Mode Coupling, by S. S. Lee and S. Y. Shin (Dept. of Elec. Eng., KAIST, Taejon, Korea): *JKITE*, vol. 34-D, no. 4, pp. 317–323, Apr. 1997.

An electro-optic polymer digital optical switch with a coupling region modified for optimum mode coupling is proposed, and it is analyzed by using the beam propagation method combined with the effective index method. Its modified coupling region is adiabatically introduced along the propagation direction from the branching point of the two waveguides. The structure of the modified coupling region and its refractive index profiles are designed to optimize the mode coupling in the Y-branch waveguide. Therefore, the switching performance of the device may be enhanced with a fixed device length. It is confirmed from the numerical calculation that the drive voltage is reduced by more than 30% and the crosstalk is improved by about 8 dB.

(12) Time-Division Hybrid WDM Photonic Switch Architecture, by K. T. Kim,* J. S. Eom,* W. C. Kim,** S. Y. Shin,** and H. S. Jung*** (*Dept. of Elec. Eng. Kangwon Nat'l Univ., Choonchun, Korea; **Dept. of Data and Comm. Eng. MyoungJi Univ., Seoul, Korea; ***Dept. of Electronics and Electronic Computer Eng. Hongik Univ., Seoul, Korea): *JKITE*, vol. 34-D, no. 5, pp. 402–410, May 1997.

Photonic switching systems with throughput above Tbit/s are required to transport vast amounts of information for the coming B-ISDN. In this paper, we proposed a new time-division hybrid WDM photonic switch architecture, the proposed basic switch module has simple configuration consisted of frequency routers for wavelength division and cell coders and star couplers for time division. Through the comparison with other systems in field of switching capacity, hardware complexity and cost effect of implementation, we proved that the proposed system is suitable for large-capacity photonic switching system.

(13) InAlAs/InGaAs Schottky Barrier Enhanced Metal Semiconductor Metal Photo Diode with Very Low Dark Current, by J. B. Kim, M. J. Kim, and S. J. Kim (School of Elec. Eng., Seoul Nat'l Univ., Seoul, Korea): *JKITE*, vol. 34-D, no. 5, pp. 411–416, May 1997.

In this paper we report the fabrication of an InGaAs metal–semiconductor–metal (MSM) photo diode (PD) with an InAlAs barrier enhancement layer that has very low dark current and high speed characteristics. The detector using Cr/Au Schottky metal fingers with 4-μm spacing on a large active area of 300 $\times$ 300 μm^2 offers a low dark current of 38 nA at 10 V, a low capacitance of 0.8 pF, and a high 3-dB bandwidth of 2.4 GHz. To our knowledge, these characteristics are better than any previously published results obtained from large area InGaAs MSM PD's. The RC equivalent model and frequency domain current response model considering transit time were also used to analyze the frequency characteristic of the fabricated device.

(14) The Wavelength Locking System of the Fabry–Perot Filter for WDM, by J. Y. Sang* and H. J. Lee** (*Global one Comm. Inc., Korea; **Dept. of Info. Comm. Eng., Hoseo Univ., Chungnam, Korea): *JKITE*, vol. 34-D, no. 6, pp. 482–488, June 1997.

The wavelength locking system of the optical Fabry–Perot filter theoretically derived and experimentally realized by using the dithering method in order to compensate the laser wavelength drift increasing the BER of the WDM system. The deviation between the laser wavelength and the optical filter center wavelength is compensated by applying a suitable voltage to the PZT. Accordingly, the laser wavelength selected by the Fabry–Perot filter always maintains the condition of maximum transmission power. A wavelength locking system has been demonstrated using a fiber Fabry–Perot filter with a free spectral range of 80 nm and an FWHM of 1 nm. The voltages of the sine wave generated for dithering was 20 and 10 mV, the frequency was 2 kHz and center wavelength of the tunable laser was 1550 nm. In this paper, the locking system have 20 ms of locking time and 2 nm of locking range.

(15) Cross Talk Analysis of Laser-Diode Array Modules for Wavelength Division Multiplexing, by S. I. Kim* and H. Y. Lee** (*Dept. of Package Development, Div. of Memory R&D, Hyundai Electronics Industries Co. Ltd., Ichon, Korea; **School of Elec. and Electrical Eng., Ajou Univ., Seoul, Korea): *JKITE*, vol. 34-D, no. 7, pp. 577–584, July 1997.

In this paper, we analyzed the cross talk characteristics of LD array modules for WDM and improved the cross talk levels using a screening line between access lines. From the calculation results, we have found that inductive cross talk of access lines is dominant for the low-impedance LD arrays with short bond wire interconnections. The proposed array interconnection with the screening line and double bond wires, reduces the cross talk level about 10 dB compared to conventional interconnections using simple access lines and a single bond wire. This proposed structure also can be easily implemented with transmission reliability.

(16) Design of a Low Loss $N \times N$ Waveguide Grating Router Composed of Multimode Interference Couplers and Arrayed Waveguide Grating, by S. W. Moon and Y. C. Chung (School of Elec. Eng. Kwangwoon Univ., Seoul, Korea): *JKITE*, vol. 34-D, no. 7, pp. 585–593, July 1997.

Until now, the most well-known configuration for waveguide grating router (WGR) is composed of radiative star couplers and arrayed waveguide grating (AWG), which usually suffer from the radiation loss of around 3 dB or more. Therefore, the improved design of WGR's is needed to reduce the loss. In this paper, we propose a novel WGR composed of multimode interference couplers which have good uniformity, fabrication tolerance, and very low excess loss, and suggest the

efficient algorithm to find the proper path length differences of AWG for given channel spacing and channel assignment to each output port. The simulated spectral responses of the proposed WGR using the finite difference beam propagation method (BPM) show that the excess loss is less than 0.3 dB and the cross talk less than -25 dB in case of 4×4 WGR, and the excess loss less than 0.4 dB and the cross talk less than -25 dB in case of 8×8 WGR for all the channel wavelengths.

(17) A Photonic Packet Switching System with Contention Resolution Capability, by K. C. Lee,* S. C. Lee,* S. K. Lee,** J. C. Jeong,*** C. H. Kang,* and J. W. Park* (*Dept. of Elec. Eng., Korea Univ., Seoul, Korea; **Korea Telecom, Korea; ***Dept. of Radio Science and Eng., Korea Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 8, pp. 662–671, Aug. 1997.

In this paper it is proposed a new architecture for $N \times N$ optical packet switching system. It consists of active-splitter type of packet router, traveling type of optical buffer memory for packet contention resolution and an electronic controller. The BER performance of the proposed switching system is analyzed with respect to channel crosstalks and amplified spontaneous emission noise from switching elements and optical amplifiers respectively. Operational validity of the proposed switching system is also experimentally proved by realizing 2×2 optical packet switching system.

(18) Proposal of Bulged-Type Abrupt Bend Structure with Low Bending Loss, by S. P. Han and C. M. Kim (Dept. of Elec. Eng., Seoul City Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 8, pp. 681–689, Aug. 1997.

Bulged-type bends with low bending loss are newly proposed, and the FD-BPM is made use of for designing optimum structure. How to evaluate bending loss of conventional bends and how to improve the bending structure based on the phase compensation concept are described in general. Besides simulation results for the bulged-type bends, results for the coupled-type bends and the chamfered-type bends are also illustrated for comparison's sake. It is concluded that the bulged-type bends show the most superior performance in terms of not only the bending loss but also the design tolerance.

(19) Utilities of Parylene Buffer Layer in $H:LiNbO_3$ Optical Modulator, by H. Huh and J. K. Pan (Dept. of Elec. Eng., Chonbuk Nat'l Univ., Jeonju, Korea): *JKITE,* vol. 34-D, no. 8, pp. 690–696, Aug. 1997.

$H:LiNbO_3$ optical modulator buffered by parylene layer, which has a merits in the band-width, power consumption, and fabrication as compared with conventional SiO_2 buffered optical modulator, is proposed and analyzed. The dependencies of velocity matching condition, characteristic impedance, and driving voltage on dielectric constants, thickness of buffer layer, and electrode configurations are demonstrated with finite element calculation. And we performed the physical and chemical test of parylene buffer layer deposited on $LiBbO_3$ and under Au electrodes.

(20) Analysis and Design of Inhomogeneous Optical Filters Using Tapered Transmission Line Theory, by Y. J. Kwon,* H. S. Jang,* S. K. Lim,** and M. H. Oh*** (*Dept. of Radio Science and Eng., Hanyang Univ., Seoul, Korea; **Dept. of Elec. Eng., Dankook Univ., Seoul, Korea; ***KIST, Seoul, Korea): *JKITE,* vol. 34-D, no. 9, pp. 732–738, Sept. 1997.

Optical filters with graded index profiles are designed by applying the Fourier transform to a Riccati equation which governs the reflection and transmission characteristics of inhomogeneous refractive index distributions. The inhomogeneous refractive index profile of an optical filter with specified target spectrum is obtained through iterations. The spectral response of the inhomogeneous refractive index layers are analyzed by using Runge–Kutta numerical method to solve the differential equations of the amplitude and the phase of reflection coefficient derived from the Riccati equation and the results are in good agreement with the results obtained by using matrix method.

(21) The Fabrication and Electrical Characteristics of Planar Multiquantum Well (MQW) Avalanche, MQW-pn, and p-i-n Photo diode Implanted with Oxygen for Electrical Isolation, by S. K. Si,* S. J. Kim,* D. Sivco,** D. L. Jacobsen,** and A. Y. Cho** (*School of Elec. Eng., Seoul Nat'l Univ., Seoul, Korea; **Bell Lab., Lucent Tech., Murray Hill, NJ. 07974, USA): *JKITE,* vol. 34-D, no. 9, pp. 739–745, Sept. 1997.

The dependence of the electrical properties in planar MQW-APD & pn, and p-i-n photo diode implanted with oxygen on the annealing temperatures and ion dose has been investigated. The oxygen implantation was performed for interdevice isolation. The leakage current of as-implanted p-i-n photo diode obtained was less than 50 nA. An annealing temperature dependence study shows an abrupt increase of leakage current at 600°C for all devices under study. This indicates that donor complex centers introduced by the chemical activity of oxygen increase with increasing annealing temperatures. Furthermore, leakage current was highly correlated with oxygen dose due to the implanted related defects.

(22) Study on the Physical Mechanism of Nonlinear Gain in Semiconductor Lasers, by C. B. Kim* and J. S. Eom** (*Dept. of Electrical, Electronics, and Info. and Comm. Eng., Kongju Nat'l Univ., Kongju, Korea; **Dept. of Elec. Eng., Kangwon Nat. Univ., Choonchon, Korea): *JKITE,* vol. 34-D, no. 9, pp. 768–775, Sept. 1997.

The dominant physical process responsible for the nonlinear gain is from spectral-hole burning with the time constant of about 50 fs and the contribution to the nonlinear gain from hot carriers effect is determined to be about 15% of the contribution due to spectral-hole burning. To prove the above results we fit the data of Hall and found that hot carriers have a profound effect on their experimental data despite the fact that the magnitude of hot carriers effect is only 15% of spectral-hole burning. We suggest that the experiment with a pump pulse width of 180 fs is very sensitive in detecting the effect of hot carriers, but is not sensitive in detecting much faster process associated with spectral-hole burning.

(23) Analysis of Ultra-Short Optical Pulse Generation by LD Gain-Switching, by Y. J. Kim, D. G. Kim, and C. M. Kim (Dept. of Elec. Eng., Seoul City Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 10, pp. 861–869, Oct. 1997.

For a InGaAsP buried-heterostructure 1.3-mum LD with Fabry–Perot cavity structure, the procedures of ultra-short

optical pulse generation are analyzed by simulating the rate equations. Investigating the effects of injected current pulse parameters such as bias J_b, pulse width T_d, and pulse amplitude J_p on the generated optical pulses, we derive the optimum conditions to obtain a single optical pulse with strong peak value. We also observe that the repetition rate of current pulses needs to be restricted under a certain threshold to generate a train of single optical pulses, and that the period doubling phenomenon takes place by increasing the repetition rate.

(24) Fabrication of a AlGaAs High Power (~20 W) Laser Diode Array, by B. H. Park, N. J. Son, J. H. Bae, and O. D. Kwon (Dept. of Elec. and Electrical Eng., POSTECH, Pohang, Korea): *JKITE,* vol. 34-D, no. 11, pp. 890–894, Nov. 1997.

We have successfully fabricated high power (~20 W) laser diode arrays, which are useful for pumping Nd:YAG lasers. The laser diode array has 20–100-μm-wide channels of which space was adjusted to 350 μm to improve thermal characteristics. And channel width is 100 μm. For an uncoated LD array, the output power of 15.66 W has been obtained at 41 A under quasi-CW operation, which results in about 0.42-W/A slope efficiency. After AR (5%) and HR (95%) coatings on both facets, the output power was improved up to 21.18 W at 40 A under the same operation as above and the slope efficiency was 0.795 W/A. On the other hand, by using a near field measurement system consisting of objective lens, eyepiece, CCD camera and image processing board, the typical near field pattern of 1×20 LD array was observed.

(25) Optimum Design of InGaAsP Electroabsorption Optical Modulator, by S. Han and S. K. Han (Dept. of Radio Comm. Eng., Yonsei Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 11, pp. 953–959, Nov. 1997.

An optimized electroabsorption modulator structure is designed for high-speed optical communication systems considering the extinction efficiency, operating bandwidth, polarization loss, and wavelength chirping. The operating wavelength region is 1.55 μm and the deep ridge structure is adapted for the minimum polarization loss. Simulations show that the absorption layer thickness larger than 0.25 μm, and the modulator length shorter than 200 μm are required for the bandwidth over 10 GHz. To obtain the modulation efficiency over 10 dB/V, a wavelength detuning needs to be determined less than 40 meV.

(26) Calculation and Experiment on Diffraction Efficiency of Pulse Beam Operating Four-Wave Mixing in Photo-Refractive Crystal, by K. Enbutsu, A. Okamoto, K. Sato, and Y. Takayama (*Faculty of Engineering, Hokkaido University, Sapporo-shi, 060 Japan; **Faculty of Engineering, Hokkai-Gakuen University, Sapporo-shi, 064 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 18–24, Jan. 1997.

We analyze temporal characteristics of diffraction efficiency of pulse operating four-wave mixing with a photo refractive $BaTiO_3$ crystal. Suppose that only transmission grating is generated in the crystal, we apply Euler's method to the set of coupled equations that give the dynamical properties of four-wave mixing in a photo refractive crystal. And we calculate a time-dependent diffraction efficiency of the phase conjugation by using pulse beam for backward pump beam. The resulting peak efficiency shows lager than one in case of continuous backward pumping. Besides, we perform a experiment in order to demonstrate the improvement of diffraction efficiency owing to the pulse operating backward pumping.

(27) Bonding Structural Design of Lenses for LD Modules, by M. Shimaoka, K. Fukuda, and T. Kumazawa (Mechanical Engineering Research Laboratory, Hitachi, Ltd., 502 Kandatsumachi, Tsuchiura-shi, 300 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 25–31, Jan. 1997.

This paper describes the structural design required to bond a lens to a holder. In the assembly process when the holder and rod lens were bonded using Pb–Sn solder, degradation of the solder occurred as a result of thermal stress during the temperature cycling test. For clarifying a method to strengthen the solder joint, the mechanical properties of Au–Ge and Au–Sn solders were measured. In addition, thermal stress analysis was carried out during the bonding process to fasten the rod lens to the holder. From the results of Au–Sn strength and the stress analysis, the stability of a new fabricated holder, made of Fe, with lens attached was tested. Au–Sn bonding of the rod lens to the holder was stable during the temperature cycling test.

(28) Zeeman Effect-Based Control-Signal Improvement for Frequency Stabilization of a Semiconductor Laser, by H. Nakano,* N. Watanabe, T. Sato,* M. Ohkawa,* T. Maruyama,* and M. Shimba** (*Faculty of Engineering, Niigata University, Niigata-shi, 950-21 Japan; **Faculty of Engineering, Tokyo Denki University, Tokyo, 101 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 55–63, Feb. 1997.

We have tried to stabilize oscillation frequency of a semiconductor laser by using the Rb–D_2 absorption line as an external frequency reference. The frequency stabilizations restricted by the Doppler width of an absorption line in principle. Then, we started to employ a scheme of the saturated absorption spectroscopy to obtain the Doppler-free spectrum. However, we could not proceed more in reduction of the spectrum width only by help of manipulations on the optical setup. In this paper, we report a new method which we refer as the PEAK and BOTTOM methods, where the Zeeman effect on the Rb-D_2 absorption line is utilized. These two methods improved oscillation frequency traceability to frequency reference by narrowing the width of the frequency discrimination curve. The stabilized frequency was also tuned within a range of 100–500 MHz.

(29) Femtosecond Fiber Laser at 10 GHz and Its Application as a Multiwavelength Optical Pulse Source, by E. Yoshida, K. Tamura, E. Yamada, and M. Nakazawa (NTT Access Network Laboratories, Tokai, Ibaraki-ken, 319-11 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 70–77, Feb. 1997.

We report the lasing characteristics of a harmonically and regenerative mode-locked erbium-doped fiber laser which emits a 1.0–3.0-ps pulse train at a repetition rate of 10 GHz in the 1.5-μm region. The output pulse was compressed to as short as 170–250 fs through the use of a dispersion-decreasing erbium-doped fiber amplifier and amplified up to an average power of 0.53 W by using a high-power erbium-ytterbium-doped fiber amplifier. The peak power was as high as 190 W. By slicing the broad spectrum of the amplified femtosecond

pulse into eight channels with an optical filter, we succeeded in producing an 80-GHz multiwavelength optical source. This source will play an important roll in wavelength-division-multiplexed transmission.

(30) Two-Dimensional Photonic Band Structure of Triangular Lattice with Additional Cylinders, by S. Isozaki, Y. Kokubo, I. Ohta, and T. Kawai (Faculty of Engineering, Himeji Institute of Technology, Himeji-shi, 671-22 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 86–87, Feb. 1997.

Triangular lattices are known as the photonic crystal in two-dimensional structure. When we added new small cylinders to the triangular lattices, we found the form is suitable for the photonic band structures.

(31) Characteristics Improvement of the Optical Isolators Integrated into a Fiber Array, by R. Kasahara, T. Sato, J. Sun, and S. Kawakami (Research Institute of Electrical Communication, Tohoku University, Sendai-shi 980-77 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 136–137, Mar. 1997.

We have constructed two parallel lens-free and alignment-free optical isolators, which are composed of an isolator chip, using a pair of rutile wedges, inserted into an array of thermally expanded core (TEC) fibers. We have obtained the insertion losses of about 1 dB and the backward losses of more than 30 dB at the wavelength of 1.555 μm. To improve the backward losses more over, we have designed and fabricated a cascaded isolator chip and experimentally confirmed its large backward loss of about 50 dB with optical alignment. These results verify the principle and usefulness of hybrid integration of functional devices into TEC fibers.

(32) Analysis of a New PIN Photo Diode for Optical Integrated Circuits, by M. Watanabe and T. Kambayashi (Faculty of Engineering, Nagaoka University of Technology, Nagaoka-shi, 940-21 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 142–143, Mar. 1997.

A new PIN photo diode suitable for optical integrated circuits is proposed and analyzed by the FDTD method. Its characteristics such as frequency bandwidth and coupling efficiency to next stage are described. In comparison with the conventional direct-integrated type, the bandwidth is almost same and the efficiency is much better.

(33) Polarization-Insensitive and Wide-Wavelength Laser-Diode Optical Switch Module, by T. Takeshita, K. Yoshino, T. Ito, Wayne LUI, K. Magari, Y. Suzuki, and M. Naganuma (NTT Opto-Electronics Laboratories, 3-1, Morinosato Wakamiya, Atsugi-shi, 243-01 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 144–146, Mar. 1997.

A laser-diode optical-switch module with less than 0.3-dB gain difference between TE and TM polarization for a wide wavelength range of 1.30–1.34 μm has been constructed by introducing a 0.3-μm-square bulk active layer, which is fabricated by using dry etching and regrown technique. The module is a good candidate for the optical gate switch in optical information systems.

(34) Demultiplexing and Routing of TDM Signal Using Wavelength Conversion by Fiber Four-Wave Mixing and Wavelength Routing by Fiber Gratings, by T. Yamamoto, T. Imai, T. Komukai, and M. Nakazawa (NTT Access Network Systems Laboratories, lbaraki-ken, 319-11 Japan): *Trans. IEICE,* vol. J80-C-1, pp. 186–194, May 1997.

Demultiplexing and routing of a 10 Gbit/s ($=$ 2.5 Gbit/s $\times 4$) time division multiplexed (TDM) signal has been achieved by using wavelength conversion via four-wave mixing in optical fiber and wavelength routing via fiber gratings and optical circulators. Each channel of the TDM signal is converted to a different wavelength by four-wave mixing in a fiber. Phase matching is achieved by setting the signal wavelength to the zero-dispersion wavelength of the fiber. By using fiber gratings in which side-lobes are suppressed by anodization, cross-talk between adjacent channels is suppressed to less than -25 dB when the wavelength separation is as small as 1 nm.

(35) Wavelength Tunable Q-Switched Fiber Laser Using Fiber Bragg Gratings, by T. Imai, T. Komukai, T. Yamamoto, and M. Nakazawa (NTT Access Network Systems Laboratories, Ibaraki-ken, 319-11 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 195–203, May 1997.

The Q-switching operation of an erbium-doped fiber laser with fiber grating mirrors was demonstrated. The resonator was formed by splicing two fiber gratings to erbium-doped fiber ends. The Q-switching operation was performed by applying periodically tension change to one of the fiber gratings using piezoelectric transducer. An output pulse with a pulse width of 2.46 ms and a peak power of 2.1 mW was obtained for the repetition rate of 1 kHz. The laser oscillation wavelength was tuned from 1.552 to 1.556 mm.

(36) The Saturation Characteristics of the Nondegenerate Four Wave Mixing in a $\lambda/4$ Phase Shifted DFB Laser, by H. Kuwatsuka, H. Shoji, T. Shimoyama, and H. Ishikawa (*Fujitsu Laboratories Ltd., Atsugi-shi, 243-01 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 253–254, May 1997.

Saturation in conversion efficiency for increasing input signal is less in nondegenerate four wave mixing in a DFB laser using its lasing beams as pump beams, when compared with semiconductor optical amplifiers. This fact gives a good ratio of conjugate to amplified spontaneous emission noise.

(37) Modulation of Submillimeter Wave Radiation by Laser-Produced Free Carriers in Semiconductors, by T. Nozokido, H. Minamide, and K. Mizuno (*Photodynamics Research Center, The Institute of Physical and Chemical Research (RIKEN), Sendai-shi, 980 Japan; **Research Institute of Electrical Communication, Tohoku University, Sendai-shi, 980-77 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 259–266, June 1997.

The use of laser-produced free carriers in semiconductors as a means of controlling submillimeter wave radiation has been investigated. Modulation of 214-μm radiation is achieved by irradiating high-resistivity silicon or GaAs wafers with optical pulses from a Q-switched Nd: YAG laser. In this modulation technique, there are three parameters which will affect the characteristics of modulation: 1) recombination time of free carriers, 2) penetration depth of optical pulses into semiconductors and 3) relative direction of the submillimeter and the optical waves irradiated into the semiconductor wafer. The effects of theses parameters are theoretically and experimentally examined. In addition, as an application of this

technique, generation of submillimeter-wave pulses of variable duration is demonstrated.

(38) Joule-Heat Optical Switching with Fiber Grating, by K. Yamada, A. Shibano, Y. Fukumoto, and O. Mikami (Faculty of Engineering, Tokai University, Hiratsuka-shi, 252 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 292–293, June 1997.

Reflection peak wavelength of fiber gratings can be easily changed by applying a heat and/or stress. In this letter, optical switching by Joule heat with a fiber grating has been studied. Heating was done by flowing an electric current through a resistor which was attached to the grating region. An optical extinction ratio of maximum 15 dB was obtained when a single-mode laser of 1.55 μm was coupled to the fiber.

(39) Frequency Stabilization of a Laser Diode Using an Etalon Pair, by H. Sakamaki, D. Tashiro, M. Shimba, and T. Sato (*Faculty of Engineering, Tokyo Denki University, 2-2 Kanda Nishiki-cho, Chiyoda-ku, Tokyo, 101 Japan; **Faculty of Engineering, Niigata University, 8050 Ikarashi, 2-no-cho, Niigata-shi, 950-21 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 300–301, June 1997.

The oscillation frequency of a laser diode changes greatly depending on the drift current and temperature. We used the Fabry–Perot–Etalon pair as a frequency standard, and used the cross-point of the resonant frequency response of the Etalon pair as a stabilization point. And we measured that the error signal of the Etalon pair is about five times better than that of an Etalon.

(40) Measurement of Recombination Coefficients of both 1.3 and 1.5 μm InGaAsP Laser Diodes, by W. Hidaka and W. Susaki (Osaka Electro-Communication Univ., Hatsucho 18-8, Neyagawa-shi, 572 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 313–318, July 1997.

Radiative and Auger recombination constants of InGaAsP lasers grown on p-substrate with low leakage current at room temperature are investigated from the lasing delay time to the input pulse current. Experimental data are fitted with theoretical values obtained from numerical calculation of rate equations taking the input current pulse form into account. Estimated threshold carrier densities n_t are (2.8–3)$\times 10^{18}$/cm^3 in these lasers. It is found that radiative recombination constant B and Auger recombination constant A are (1–1.5) $\times$ 10^{-10}cm^3/s and $<0.05 \times 10^{-28}$cm^6/S for both 1.3-μm PBC and 1.5-μm PPIBH InGaAsP lasers, respectively, which means Auger recombination An_t^3 is negligibly small compared with radiative recombination Bn_t^2 in these lasers.

(41) Negative Amplification of Optical Signal Derived from Negative Nonlinear Absorption Effect in Er-Doped Fibers, by Y. Maeda, T. Sakakibara, and M. Migitaka (Department of Information and Control Engineering, Toyota Technological Institute, Hisakata 2-12-1, Tempaku-ku, Nagoya-shi, 468 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 319–327, July 1997.

Dependence of negative nonlinear absorption effect on modulation degree of the incident laser was investigated in 470-ppm erbium-doped fibers at 77 and 300K. Negative amplification of optical signal was observed because the ratios of the transmitted modulation degree to the incident one were negative amplification factors for fiber lengths greater than 2 m. In addition, the phenomena were seen at wavelengths of 784 to 792 nm and in the incident laser intensity range of 3 mW/cm^2. The phase of transmitted laser was opposite to that of incident laser at modulation frequency up to 1 MHz. However, the transmitted laser waveform. was asymmetrical with increasing modulation frequency. It was suggested that the emission caused in the fiber can contribute to the negative nonlinear absorption effect efficiently.

(42) Nonlinear Characteristics of a Smith–Purcell Free-Electron Laser, by A. Hirata and T. Shiozawa (Faculty of Engineering, Osaka University, Suita-shi, 565 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 361–367, Aug. 1997.

With the aid of particle simulation, we discuss nonlinear saturation and efficiency enhancement in a single-pass Smith–Purcell free-electron laser, taking into account the nonlinear properties of a relativistic electron beam. For the analysis of the problem, we consider a two-dimensional model which is composed of a planar relativistic electron beam and a parallel plate waveguide, one plate of which is loaded with a metallic grating. The result of numerical simulation shows that the efficiency in energy transfer from the electron beam to the electromagnetic wave is enhanced by tapering slot widths in a metallic grating.

(43) Piezoelectric Copolymer Jacketed Fiber-Type Mode-Locked Laser, by S. Sato and M. Imai (Faculty of Engineering, Muroran Institute of Technology, Muroran-shi, 050 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 374–379, Aug. 1997.

We describe a fiber-type mode-locked laser operating at 1.06 μm with a piezoelectric copolymer jacketed fiber for intrafiber phase modulation, that is, direct modulation of the phase of the mode field in optical fiber. The fiber used as active medium of the laser was a 103.3 cm length of 4.0-μm core diameter, doped with Nd^{3+} ions at a concentration of 180 parts in 10^6 wt. A part of the fiber laser constitutes an all-fiber phase modulator which permits us a low-loss cavity design and highly efficient mode-locking. Mode-locked pulses with a 2.2-ns duration (FWHM) were obtained at a repetition rate of 98.12 MHz. In future work, the mode locked pulses in Fourier-transform limited regime will be investigated in detail by measurements of the spectrum.

(44) InGaAs/GaAs Vertical-Cavity Surface-Emitting Lasers with AlAs Selective Oxide Layers, by N. Hatori, T. Mukaihara, N. Ohnoki, A. Mizutani, M. Abe, A. Matsutani, F. Koyama, and K. Iga (Precision and Intelligence Laboratory, Tokyo Institute of Technology, 4259 Nagatuta, Midoriku, Yokohama-shi, 226 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 407–413, Sept. 1997.

In this paper, we discussed the design of In GaAs/GaAs vertical-cavity surface-emitting lasers (VCSEL's), and showed the possibility of low threshold operation of VCSEL's below 100 μA. Next, we adopted an AlAs oxide layer which is desirable for realization of low-threshold VCSEL's, and evaluated the AlAs oxide layers formation basically. We fabricated a novel InGaAs/GaAs VCSEL's using AlAs oxide layers of distributed Bragg reflector and achieved an extremely low threshold current operation of 70 μA. We predicted that further

low-threshold should be expected by controlling oxidation process.

(45) Observation of Spectral Hole Burning in Photo current of InAs Self-Assembled Quantum Dots Embedded in Pin Diode, by Y. Sugiyama,* Y. Nakata,** S. Muto,*** N. Horiguchi,** T. Futatsugi,* Y. Awano,* and N. Yokoyama* (*Fujitsu Limited, 10-1 Morinosato-Wakamiya, Atsugi-shi, 243-01 Japan; **Fujitsu Laboratories Ltd., 10-1 Morinosato-Wakamiya, Atsugi-shi, 243-01 Japan; ***Division of Applied Physics, Faculty of Engineering, Hokkaido University, Kita-13, Nishi-8, Kita-ku, Sapporo-shi, 060 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 424–425, Sept. 1997.

Spectral hole burning of InAs self-assembled quantum dots (QD's) embedded in p-i-n diode was observed for the first time. The spectral hole depth increased as electric field increased. From numerical fitting results, the possibility of wavelength-domain multiplicity of optical memory using InAs QD's was also shown.

(46) Quasi-Phase-Matched Up Converter Demultiplexer by Scanning Incident Angles and Wavelength, by K. Koyanagi (Faculty of Engineering, Hokkaido University, Sapporo-shi, 060 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 427–429, Sept. 1997.

Wider-spaced signal wavelengths can be represented as angular distribution of the up-converted light with the maximum conversion efficiency by scanning the signal incident angle satisfying the quasi-phase-matched condition of three-wave sum-mixing in a $LiNbO_3$ crystal. Narrow-spaced optical channels can be demultiplexed by scanning the wavelength and incident angle of the pumping light.

(47) The Applicability of High-Power Laser Diodes to Optical Intersatellite Links, by N. Morimoto,* M. Noda,** and T. Takano*** (*Graduate Course of Engineering, University of Tokyo, Bunkyou-ku, Tokyo, 113 Japan; **Mitsubishi Electric Corporation, Information Technology R&D Center, Kamakura-shi, 247 Japan; ***The Institute of Space and Astronautical Science, Sagamihara-shi, 229 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 433–441, Oct. 1997.

Laser diode (LD) is investigated as a suitable light source of LD transmitter for an optical intersatellite link, and should have the characteristics of high power, a single-lobed beam and fast response. Concerning high-power laser diodes of 1-W output class, the radiation, polarization, and modulation characteristics have been examined. It is shown that signal modulation band width of about 300 MHz and output power of about 750 mW is possible. And it is shown that the modulation band width can be expanded to about 400 MHz by improving the driver circuit. However, the pattern degradation and harmonics generation at high output level are problems to be solved in future for optical intersatellite link.

(48) Frequency Stabilization of 633-nm He–Ne Laser by Using Frequency Modulation Spectroscopy of $^{127}I_2$ Enhanced by an External Optical Cavity, by F. Murakami,* M. Tukuda,** Y. Shoji,** K. Narumi,** and T. Ohta** (*Laboratory, Japan Radio Co., Ltd., 2-1-4 Fukuoka, Kamifukuoka-shi, 356 Japan; **Faculty of Engineering, Doshisha University, 1-3 Tadaramiyakotani, Kyotanabe-shi, 610-03 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 442–449, Oct. 1997.

The two-mode stabilized 633-nm He–Ne laser have been stabilized to the hyperfine structure of the P (33) line of $^{127}I_2$ by means of frequency modulation spectroscopy enhanced by an external optical cavity. When the red side (lower frequency) mode of the laser is locked to the a component of the P (33) line, both the red side and blue side (higher frequency) modes of the laser exhibit the frequency stability of $2.3 \times 10^{-11} \times \tau^{-1/2}$. The frequency of the a component relative to the i component of the R (127) line has been measured as a function of iodine pressure. In addition, the frequency separation of a of j components of the P (33) line has been measured.

(49) Analysis and Design of Widely Tunable, Diode-Pumped Cr : LiSAF Lasers with External Grating Feedback, by M. Tsunekane,* M. Ihara,** N. Taguchi,* and H. Inada*** (*Biophotonics Information Laboratories, Yamagata High Tech. R&D Cnt. 2-2-1 Matsuei, Yamagata-shi, 990 Japan; **Shimadzu Corporation, Technology Research Laboratory, 3-9 Hikaridai, Seika-cho, Soraku-gun, Kyoto-fu, 619-02 Japan; ***Tohoku Institute of Technology, 35-1 Yagiyama-Kasumi-cho, Taihaku-ku, Sendai-shi, 982 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 450–460, Oct. 1997.

We report theoretical and experimental studies on the tuning characteristics of a diode-pumped single-longitudinal-more Cr : LiSAF laser with external optical feedback from diffraction grating. The results of theoretical analysis explained the mechanism of wave-length tuning and agreed well with the measured characteristics. The simple relation, which describes the dependence of the threshold power on the reflectivity of the output coupler and on the feedback from the grating, was derived taking account of the wave-length dependence of the Cr : LiSAF emission cross section. From these results we could optimized the reflectivity of the coupler for achieving broad band tuning. It was found that the tuning range of 200 nm is possible if the feedback ratio from the grating is increased to 35%.

(50) Design and Analysis of Monolithic Q-Switch Nd^{3+} : YLF Waveguide Laser Using Poled-Polymer Film as Guiding Layer, by S. Yamakawa,* T. Kinoshita,* K. Sasaki,* and T. Taniuchi** (*Department of Electrical Engineering, Faculty of Science and Technology, Keio University, 3-14-1, Hiyoshi, Kouhokuku, Yokohama-shi, 223 Japan; **Research Institute of Electrical Communication, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai-shi, 980-77 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 501–509, Nov. 1997.

Design and numerical analysis of a novel monolithic Q-switched Nd : YLF waveguide laser are described combination of a Nd : YLF crystal substrate and copolymer film, disperse red 1 covalent introduce PMMA, provides direct electro-optic modulation. The integration of an intracavity directional coupler electro-optic modulator performs Q-switch operation. Numerical analysis taking the modal power profile in the waveguide into consideration shows low thresholds as low as 1.46 mW and slope efficiency up to 36% for continuous wave operation. Calculation of time-evolution calculation indicates Q-switched pulse generation of 0.46-kW peak power and 768-ps duration under 100-mW CW pumping and 38.5 V of modulation voltage.

(51) Bistability Control by Forward Pump Beam in Photo Refractive Four-Wave Mixing, by Y. Takayama,* A. Okamoto,* and K. Sato** (*Faculty of Engineering, Hokkaido University, Sapporo-shi, 060 Japan; **Faculty of Engineering, Hokkai-Gakuen University, Sapporo-shi, 064 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 510–516, Nov. 1997.

The bistability control by the forward pump beam in photo refractive four-wave mixing is analyzed. It is assumed that the transmission grating is generated in the crystal. The equation which offers the bistability condition is derived for the first time under the condition that the forward pump beam is turned off. The temporal property of the four-wave mixing is also analyzed with two different initial conditions. And a method to control the bistability is proposed. Besides, the temporal and spatial variation of the transmission grating is shown to explain the process of the bistability.

(52) Wavelength Demulti/Multiplexers with Nonsinusoidal Filtering Characteristics Composed of Point-Symmetrically Connected Mach–Zehnder Interferometers, by Y. Hida, K. Jinguji, and N. Takato (NTT Opto-electronics Laboratories, Ibaraki-ken, 319-11 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 517–524, Nov. 1997.

Waveguide-type wavelength demulti/multiplexers (WDM) with non-sinusoidal filtering characteristics for optical communication system were demonstrated using Mach-Zehnder interferometers (MZI) composed of point-symmetrically connected MZI optical couplers. Three types of WDM: 1) a 1.3/1.55-μm wide-band WDM; 2) a partially coupled 1.3/1.55-μm wide-band WDM for fiber line testing; and 3) 1.3- and 1.55/1.65-μm WDM were designed by appropriately setting the wavelength characteristics of the directional couplers and the path differences of the waveguide arms in the MZI-WDM's. These WDM's were fabricated using silica-based planar light wave circuit technology and the measured results were in good agreement with the designed characteristics.

(53) Performance of GaAs MESFET Photodetectors with Wide Drain-to-Gate Distances in Subcarrier Optical Transmission, by T. Shimizu, M. Nakatsugawa, and H. Ohtsuka (Radio Systems Laboratory, NTT Wireless Systems Laboratories, Yokosuka-shi, 238-03 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 160–167, Jan. 1997.

This paper presents the performance of a proposed GaAs MESFET photo detector with wide drain-to-gate distances for improving the optical coupling efficiency in subcarrier optical transmission. Principle and design parameters of the proposed MESFET are described. Link gain, CNR, and BER, are experimentally investigated as functions of the drain-to-gate distance. It is experimentally found that the proposed MESFET improves the link gain by 8.5 dB compared to the conventional structure at the subcarrier frequency of 140 MHz. Discussions are also included compared to PIN-PD.

(54) Hillock-Free Aluminum-Based Alloy Interconnections for Active-Matrix Liquid-Crystal Displays, by K. Kato, T. Wada,† N. Kakuda,†† and T. Kawada††† (NTT Integrated Information & Energy Systems Laboratories, Musashino-shi, 180 Japan; †Presently, with Taikisha Co., Ltd.; ††Presently, with NTT Advance Technology Co.; †††Presently, with Applied Komatsu Technology, Inc.): *IEICE Trans. Electron.,* vol. E80-C, pp. 320–326, Feb. 1997.

A method is proposed for forming hillock-free aluminum-based alloy bus lines for active-matrix liquid-crystal displays (LCD's). Aluminum (Al)-based alloy films are deposited using an Al target containing boron (13) or nickel (Ni) in a sputtering ambient containing nitrogen. The Al–Ni films deposited using an Al target containing Ni showed excellent hillock resistance: virtually no hillock formation after thermal treatment at around 400°C and no significant increase in resistivity. These films also showed good patternability with a simple wet etching: a smooth line edge and a gently tapered profile. These films are thus suitable for the bus lines of active matrices.

(55) Wavelength Upconversion Demultiplexer Using Beam Deflection by Pockels Effect, by K. Koyanagi (Faculty of Engineering, Hokkaido University, Sapporo-shi, 060 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 1499–1502, Nov. 1997.

A new optical wavelength demultiplexer using quasi-phase-matched sum-frequency-generation (QPM-SFG) is proposed. The device consists of an optical deflector using Pockels effect and a nonlinear crystal with a periodic structure. The demultiplexing characteristics of the device composed of a $LiNbO_3$ crystal are analyzed theoretically. Wavelength demultiplexing can be made simply by changes in the electric field applied to the deflector.

VII. Optical Fibers/Waveguides

(1) Polarization Characteristics Comparison Between Double and Triple Clad Elliptical Fibers, by Q.-H. Nie, X.-B. Zeng, and J.-F. Dong (Ningbo University, Ningbo, P.R.C.): *JCIC,* vol. 18, no. 2, pp. 83–88, Feb. 1997.

The scalar variational analysis based on Gaussian approximation of fundamental mode is applied to triple-clad elliptical fibers with two inner claddings. The polarization properties varied with the radio of major axis to minor axis, the ratio of the inner cladding major axis to the core major axis and the refractive index differences are studied. The differences between triple-clad and double-clad elliptical fibers are also examined.

(2) Gaussian-Based Approximation for Modeling Dispersion Shifted Single-Mode Fibers, by Y. Xie (Telecommunication Metrology Center of MPT, Beijing, P.R.C.): *JCIC,* vol. 18, no. 10, pp. 26–30, Oct. 1997.

Modeling of single-mode dispersion-shift fibers based on the Gaussian approximations is proposed. It can be used to calculate the dispersion, mode field diameter, and the effective area for nonlinear interaction from the fiber or perform refractive index profiles. Calculated and measured results agreed well with each other.

(3) Research on Reducing Polarization Mode Dispersion in Single Mode Fiber, by Y.-D. Gong, F.-Y. Jiang, Z.-A. Jiang, and S.-S. Jian (Institute of Lightwave Technology, Northern Jiao-tong University, Beijing, P.R.C.): *JCIC,* vol. 18, no. 11, pp. 48–50, Nov. 1997.

By the mode coupling theory, attempt is made to strengthen mode coupling in single mode fiber through spinning when drawing, so that polarization mode dispersion in single-mode

fiber can be reduced drastically and it can maintain below 0.5 ps/$\sqrt{\text{km}}$.

(4) Development of a Sapphire Fiber Thermometer, by L.-H. Ye and Y.-H. Shen (Zhejiang University, Hangzhou, P.R.C.): *JIMW,* vol. 16, no. 6, pp. 437–442, Dec. 1997.

The development of a sapphire fiber thermometer using two wavelength bands was reported. Theoretical and experimental studies were made on its thermal radiance. A sapphire fiber thermometer using two wavelength bands was developed for use from 800 to approximately 1700°C. The instrument has the accuracy of 0.2% at 1000°C and a resolution of 1°C.

(5) Asymmetric Etched Optical Fiber Sensor Array and Its Neural Network Processing, by X.-B. Ren, J.-L. Yang, and D.-X. Huang (Huazhong University of Science and Technology, Wuhan, P.R.C.): *JAS,* vol. 15, no. 4, pp. 408–412, 1997.

A new fiber sensor array which is made of asymmetric periodically etched multimode optical fiber is described. It may be applied to detect structure state such as strain and stress, or damage assessment in smart material and structures. The method, model of array sensing signal processing in artificial neural network are described, and the simulation results of BP network are also given.

(6) Wide-Band Design of X-Cut $LiNbO_3$ Optical Modulator Employing a Ridge Waveguide, by H. Huh, H. J. Kim, and J. K. Pan (Dept. of Elec. Eng., Chonbuk Nat'l Univ., Jeonju, Korea): *JKICS,* vol. 22, no. 1, pp. 89–95, Jan. 1997.

X-cut y-propagation $LiNb0_3$ optical modulator is analyzed by finite-element calculation. The purpose of this trial is the design of wide-bandwidth x-cut $LiNb0_3$ optical modulator with ridge waveguide, which was only applied to z-cut $LiNbO_3$ optical modulator. The simulation tool is examined by the comparison between our results and Becker's. And we consider the optimum position of optical waveguide to electrodes for decreasing the driving voltage. The calculated driving-voltage, characteristic impedance, and microwave effective index at 1.3-μm optical wave length are 18 V·cm, 48.13 Ω, and 2.168, respectively.

(7) The Requirements of High-Speed Optical Fiber Studied with 2.5 Gbps × 8 channel, 123 km Transmission Using Ready-Deployed Optical Cable, by Y. G. Park, Y. H. Kang, I. S. Kim, and C. J. Chae (Trans. Tech. Res. Lab., Korea Telecom, Korea): *JKICS,* vol. 22, no. 2, pp. 291–297, Feb. 1997.

A 2.5 Gbps × 8 channel WDM signal was transmitted using ready-deployed 123-km optical cable around Daejon area. An error free transmission was achieved with 10^{-10} criterion, but the receiver sensitivity varied depending on channel, and some channel showed BER floor. The reason was found to be in reflection points, and the effects of multiple reflections on the ultra high bit transmission was analyzed in this paper.

(8) Analysis of Rectangular Dielectric Waveguide Using Perturbation Feedback Method, by Y. J. Kang*, D. H. Shon**, and S. Y. Kim* (*Dept. of Elec. Eng., WonKwang Univ., Iksan, Korea; **Dept. of Elec. Comm., Koonjang Industry College, Koonsan, Korea): *JKICS,* vol. 22, no. 8, pp. 1833–1841, Aug. 1997.

Rectangular dielectric waveguides, the most fundamental and indispensible elements in integrated optics have been investigated by many researchers with various approaching methods including from the relatively approximate techniques to the numerical method.

In this paper, the optimum equivalent waveguide model is adopted which is determined by a perturbation feedback process for analyzing rectangular dielectric waveguide. Comparing and analyzing the propagation constant by means of computer simulation, we have ascertained that the propagation constant from perturbation feedback method gives the best approximate value because it coincide with more exact value than obtained by other approximating methods. The technique also provides analytical expression for the modal field profile that should be useful in the design of various integrated optical devices.

(9) Analysis of Characteristics on Symmetric/Asymmetric Broadside-Coupled Coplanar Waveguide Using the Spectral Domain Approach, by T. H. Yoo,* I. P. Hong,* Y. K. Lee,* and H. K. Park** (*Dept. of Elec. Eng., Yonsei Univ., Seoul, Korea; **Dept. of Radio Eng., Yonsei Univ., Seoul, Korea): *JKICS,* vol. 22, no. 9, pp. 1968–1974, Sept. 1997.

In this paper, the spectral domain approach is employed to investigate the characteristics of symmetrical and asymmetrical broadside-coupled coplanar waveguides (BSC-CPW). These structures have large even (c)-odd(π) mode-velocity ratio, suitable for wide-band and tight-coupling microwave circuit design. Efficient design parameters can be obtained from the effective dielectric constants and characteristic impedances calculated by varying the strip widths and slot widths in the BSC–CPW structure.

(10) Review of Analysis for Dielectric Rectangular Waveguides, by Y. T. Kim,* B. C. Kim,** and M. Y. Lee** (*Dept. of Radio Comm. Eng., Kimchon College, Kimchon, Korea; **Dept. of Elec. Eng., Yeungnam Univ., Taegu, Korea): *JKICS,* vol. 22, no. 12, pp. 2819–2827, Dec. 1997.

A dielectric waveguide structure using rectangular dielectric strip is analyzed directly in terms of the wave equation for quasi-TE and quasi-TM modes. This problem can be solved, with no approximation in the wave equation for the electric field E and magnetic field H inside and outside the dielectric rectangular waveguide matching the boundary conditions between interfaces. This leads to an eigenvalue problem where spurious modes do not appear. Dispersion characteristic examples are presented for square and rectangular waveguides. The formulation is general and can be used for comparison with other methods such as FDM or FEM in various structures.

(11) Determination of the Dispersion Profile of a Dispersion Decreasing Fiber and the Input Pulse Amplitude for Efficient Adiabatic Pulse Compression, by B. S. Choi and D. S. Seo (Dept. of Elec. Eng., MyongJi Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 3, pp. 223–230, Mar. 1997.

We determine the dispersion profile of a dispersion decreasing fiber (DDF) for optimum pulse compression from a tradeoff between high pulse compression and low pedestal power/short DDF length. We find that the optimum value of the exponential dispersion decreasing factor α is 0.95 and that the

corresponding optimum fiber length is 1.5 times of the initial solution period. Passing through the DDF, ~10 times of pulse compression ratio can be achieved without significant increase in pedestal power. To compress relatively broad pulses using a given DDF optimized at a specific pulse width, we also determine the optimum input pulse amplitude, as a function of input pulse width.

(12) Optical Add/Drop Multiplexer for WDM System Using Fiber Bragg Grating, by S. Y. Kim,* S. B. Lee,* S. S. Choi,* J. Chung,** S. Y. Kim,** I. J. Park,** and J. C. J*** (*Photonic Research Center, KIST, Seoul, Korea; **Lab. of Trans. Tech. Research, Korea Telecom, Korea; ***Dept. of Radio Eng., Korea Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 4, pp. 336–342, Apr. 1997.

We demonstrate a novel wavelength-division add/drop multiplexer employing fiber Bragg gratings and polarization beam splitters. The multiplexer is easy to fabricate without any special technique such as UV trimming, and yet shows very stable performance with less than 0.3-dB crosstalk power penalty in a 0.8-nm-spaced 2.5 Gbps-per-channel WDM transmission system. We find that the rejection of adjacent channels is more than -26 dB, and the signal leakage through output port is less that -34 dB.

(13) Optimization of Parasitic Inductance for Maximizing the Modulation Bandwidth of MQW Modulators, by B. N. Kim and H. Y. Lee (School of Electrical and Elec. Eng., Ajou Univ., Suwon, Korea): *JKITE,* vol. 34-D, no. 6, pp. 444–450, June 1997.

An optimum parasitic inductance is observed for maximizing the modulation bandwidth of the multiple quantum well (MQW) electro-absorption optical modulator. For 1.1 pF device capacitance of the current MQW optical modulator, the optimum parasitic inductances for maximum bandwidth are calculated for different terminating resistors. In case of 50 Ω terminating resistor, the 3-dB modulation bandwidth can be increased 45% wider by using the optimum parasitic inductance that nothing parasitic inductance. This calculated optimum inductance can be practically implemented, since the parasitic inductance of bondwires can be accurately analyzed using the method of moments (MoM) and controlled by changing the length and shape of bondwires.

(14) Photorefractive Volume Hologram Recording by Single-Mode Fiber with Irregularly Etched Face, by K. H. Kim, Y. H. Kang, and B. H. Lee (School of Elec. Eng., Seoul Nat'l Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 11, pp. 918–923, Nov. 1997.

Volume hologram was recorded using reference beam from optical fiber taper. A single-mode fiber was chemically etched to make a taper structure, and we showed experimentally that the referencing by the irregular beam pattern from this taper structure could increase the storage density of photorefractive volume hologram. The spatial selectivity of the volume hologram with this method was increased by two times compared to the normal single-mode fiber referencing case. A theoretical analysis with randomly phased plane model also confirmed the results.

(15) Design of Double-Clad Dispersion-Compensated Fiber at $\lambda = 1.55$ μ: Step & Triangular Index Profile, by S. A. Kim and C. M. Kim (Dept. of Elec. Eng., Seoul City Univ., Seoul, Korea): *JKITE,* vol. 34-D, no. 11, pp. 924–933, Nov. 1997.

The 1-D finite-element method is applied for designing double-clad optical fibers with dispersion-compensation capability. Design parameters allowing only a LP_{01} single mode are treated and macro-bending loss are taken into consideration. Design parameters are extracted to have the compensation ratio (L_{SMF}/L_{DCF}) of 6.2 for core structure with, step-index profile, and of 5.2 for core with triangular-index profile.

(16) Fabrication of a Wavelength Division Multiplexer Based on the Polymeric Arrayed-Waveguide Grating, by T. W. Oh, W. Y. Lee, and S. Y. Shin (Dept. of Elec. Eng., KAIST, Taejon, Korea): *JKITE,* vol. 34-D, no. 11, pp. 940–945, Nov. 1997.

A wavelength division multiplexer based on a polymeric arrayed-waveguide grating has been designed and fabricated. A 4-channel multiplexer with a spacing of 3.2 nm is designed by using the 2-dimensional beam propagation method. A UV-curable epoxy, NOA73, is used for the core layer, and a passive polymer, PMMA, for the cladding layer. The polymer waveguides are fabricated by the reactive ion etching method and their optical properties are characterized. The fabricated device has a center wavelength of 1548.3 nm, and the wavelength spacing between the channels is 3.2 nm. The measured crosstalk is better than -18 dB.

(17) The Characteristics of Optical Waveguides and IDT Electrodes Fabricated for Acousto-Optic Tunable Filters, by H. D. Yoon, S. P. Han, S. K. Kim, Y. M. Im, and D. W. Yoon (KETI, Pyungtaek, Korea): *JKITE,* vol. 34-D, no. 11, pp. 946–952, Nov. 1997.

The characteristics of optical waveguides and IDT electrodes fabricated for acousto-optic tunable filters (AOTF) used for optical communications were analyzed. A $Ti:LiNb0_3$ in-diffusion method was employed for the formation of the optical waveguide with a dimension of with a dimension of width 8 μm, length 3000 μm, and thickness 1150 Å. The diffusion was carried at 1050°C for 8 h to pattern the optical waveguide with Ti. The resulted waveguide exhibited a single mode at a 1550-nm wavelength range and its propagation loss was less than 0.5 dB/cm. The width of IDT, with 10 SAW periods, was 5000 μm S_{11} reflection characteristics and impedances of the electrodes deposited with Au were analyzed using a network analyzer; 48.1 Ω at the center frequency of 193 MHz for Au deposition thickness of 1500 Å and 50.7 Ω at the center frequency of 192 MHz for Au deposition thickness of 1600 Å.

(18) Laser Sensor Wavelength Interrogation Using a Long-Period Fiber Grating, by M. H. Song,* S. B. Lee,** S. S. Choi,** H. Nam,* and B. G. Lee* (*School of Elec. Eng., Seoul Nat'l Univ., Seoul, Korea; **Photonics Research Center, KIST, Seoul, Korea): *JKITE,* vol. 34-D, no. 12, pp. 1053–1058, Dec. 1997.

We present a fiber laser sensor that uses a fiber grating as a strain sensor head and an end-reflector of the laser cavity. A passive wavelength demodulator composed of a long-period fiber grating and a 3-dB coupler was used for the interrogation of strain-tuned lasing wavelength. The long-period grating

band-rejection filter showed a wide usable filter wavelength range of about 25 nm, and the intensity of transmitted light increased by 16% for 1-nm sensor wavelength shift in the measurement range.

(19) Excitation Analysis of Symmetric TE_0 Waves Guided Through Symmetric Kerr-Like Nonlinear Slab Waveguides, by S. Okafuji and T. Inenaga (Faculty of Engineering, Fukuoka University, Fukuoka-shi, 814-80 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 11–17 Jan. 1997.

The excitation of symmetric stationary TE_0 waves guided by symmetric Kerr-like nonlinear slab waveguides is discussed. An analytical formulation of symmetric TE waves is presented and a numerical result for the relation between the guided wave power and the effective index is shown for symmetric TE_0 waves. The excitation analysis using the finite-difference beam propagation method reveals that symmetric TE_0 waves can be efficiently excited by Gaussian input beams and its excitation is not sensitive to an axial displacement of the input beam for waveguides with the suitable core thickness. The excitation characteristics for the variations of the input beam flux or the input beam width is also examined numerically.

(20) Application of Fiber Bragg Gratings to Spectral Filtering, by T. Komukai, T. Yamamoto, T. Imai, and M. Nakazawa (NTT Access Network Systems Laboratories, Ibaraki-ken, 319-11 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 32–40 Jan. 1997.

We fabricated high-quality fiber Bragg gratings using the UV scan radiation technique and applied these gratings as transmission-type band pass filters. Techniques for improving wavelength selectivity and for bandwidth broadening are discussed. We also applied the filters to spectrally filter pulses from a gain-switched DFB laser and a passively mode-locked fiber laser. Transform-limited pulses were obtained.

(21) Synthesis of Programmable Optical Frequency Filter with Lossy Waveguides, by K. Jinguji, K. Takiguchi, and K. Okamoto (NTT Opto-Electronics Laboratories, Ibaraki-ken, 319-11 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 335–342 July 1997.

A method extended to consider waveguide loss is presented for synthesizing programmable finite-impulse-response (FIR) optical frequency filters constructed by cascaded nonsymmetric Mach–Zehnder interferometers. It is confirmed that programmable optical frequency filters with lossy waveguides can realize arbitrary transmission characteristics in a similar manner as those with lossless waveguides. A method considered waveguide loss is also described for synthesizing infinite-impulse-response (IIR) optical frequency filters constructed by cascaded symmetric Mach–Zehnder interferometers with ring waveguides. It is shown that the optical filters have a critical waveguide loss over which the optical filters cannot be designed.

(22) Coupling Between Stacked Waveguides Using Grating Couplers, by Q. Xing, S. Ura, T. Suhara, and H. Nishihara (Faculty of Engineering, Osaka University, Suita-shi, 565 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 461–468, Oct. 1997.

Optical coupling between stacked waveguides by grating couplers integrated on each guiding layer was proposed for use in multistory waveguide devices. The coupling characteristics, such as power transfer, coupling efficiency, wavelength selectivity, were analyzed based on the coupled-mode theory. It was found that in forward coupling there is very small wavelength selectivity and the coupling efficiency cannot be very high. In backward coupling, on the other hand, a very sharp wavelength selectivity and a very high coupling efficiency can be obtained. A backward coupling device was designed, fabricated, and characterized for 0.8-μm coupling wavelength using TE modes. A 0.3-nm wavelength bandwidth of coupling efficiency, close to the calculated result of 0.2 nm, was obtained and a very sharp wavelength-selective coupling was demonstrated experimentally.

(23) Characteristics of Polarization Splitter Constructed from Coupled Two Optical Fibers, by K. Kameda,* S. Furukawa,** and T. Hosono* (*College of Science and Technology, Nihon University, Tokyo, 101 Japan; **Sano International Information Junior College, Sano-shi, 327 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 491–500, Nov. 1997.

In this paper, we discuss the characteristics of the device lengths and the bandwidth in terms of the structural parameters for polarization splitters (x-polarization type and y-polarization type) constructed from coupled two optical fibers (Fibers 1 and 2). When a_1, and a_2/a_1, (a_1, is the core radius of Fiber 1 and a_2 is the core radius of Fiber 2) have varied, the main results are as follows: 1) optimum core radius is found for x- and y-polarization type splitter that minimize the device length; 2) for $a_2/a_1 = 1.0$ the device lengths of both types become minimum; and 3) the bandwidth for $a_2/a_1 = 1.0$ can be made wider than that for $a_2/a_1 = 0.6$, 1.1.

(24) Theoretical Estimation of the Pick-Up Characteristics of the Fiber Probe Illuminated by Evanescent Field, by Y. Ishido (Life Electronics Research Center, Electrotechnical Laboratory, Amagasaki-shi, 661 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 184–189, Jan. 1997.

In this letter, a theoretical estimation of pick-up characteristics of the fiber probe for Photon Scanning Tunneling Microscopy based on the Wiener–Hopf technique taken account of the weakly guiding approximation are reported. As a result, it is found that diffracted waves by the extremity of the fiber probe mainly act on the mode excitation rather than transmitted waves, then the pick-up characteristics are well accordance with typical experiments quality and quantity.

(25) A New Physical Contact Connection Method Using the Buckling Force of Optical Fiber, by M. Kobayashi, S. Iwano, R. Nagase, and S. Mitachi (*NTT Optoelectronics Laboratories, Ibaraki-ken, 319-11 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 334–339, Feb. 1997.

Fiber physical contact (FPC) is proposed and demonstrated as a new method designed to enable fibers to be connected easily with a small structure while maintaining high optical performance. FPC is performed by mating two bare optical fibers in a micro sleeve and fixing them to a holder while they are buckled. Buckling is a phenomenon whereby a long column is bent by compression along its length. PC connection is realized by the buckling force of the fibers themselves and does not require any springs. Optical fiber buckling is studied both theoretically and experimentally. The buckling force, which is determined by an initial span between the

optical fiber holding points, remains constant when the span is changed and is useful as the PC force. The buckling amplitude which is determined by the span reduction must be so small that it does not cause excess radiation loss. A suitable span is about 7 mm. This generates a 0.7 N. The allowed span reduction is 0.1 mm. This results in a buckling amplitude of 0.64 mm which prevents radiation losses of above 0.1 dB for 1.31-μm light. Based on a study of fiber buckling, we demonstrate the optical performance for FPC connection with a 0.126-mm-diameter micro sleeve in which optical fibers are mated and with polished fiber end faces. The insertion loss is under 0.3 dB and the average return loss is 50 dB for 13.1-μm light. These values are stable in the -20 to 70°C temperature range. We confirm that FPC connection realizes high optical performance with a small simple structure.

(26) Coupling Coefficients and Random Geometrical Imperfections of an Image Fiber, by A. Komiyarna (Osaka Electro-Communication University, Neyagawa-shi, 572 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 717–719, May 1997.

Random fluctuations of the propagation constants of modes along the fiber axis are taken into consideration and the power coupling coefficient between cores of an image fiber is theoretically derived. For the fiber used for the measurement in the previous paper (A. Komiyama, *IEICE,* vol. E79-C, no. 2 pp. 243–248, 1996) it is verified that the coupling coefficient can be described in terms of statistical properties of the propagation constants in the cross section of the fiber.

(27) Observation of Mode in Graded-Index Optical Fibers with Bending and Cross Talk in MDM, by Y. Shinmura, H. Ezoe, and M. Yoshikawa (Faculty of Science, Yamaguchi University, Yamaguchi-shi, 753 Japan): *IEICE Trans. Electron.,* vol. E80-C, pp. 828–830, June 1997.

Cross talk in mode-division multiplexing system is studied. The mode patterns when the fiber is bent are observed in the experiment.

(28) Model for Estimating Bending Loss in the 1.5 μm Wavelength Region, by K. Tsujikawa,* M. Ohashi,* and O. Kawata** (*NTT Access Network Systems Laboratories, Ibaraki-ken, 319-11 Japan; **NTT Access Network Systems Laboratories, Tsukuba-shi, 305 Japan): *MICE Trans. Electron.,* vol. E80-C, pp. 1067–1069, July 1997.

A model for estimating the bending loss of 1.3-μm zero-dispersion single-mode fibers at 1.58 μm from the value at 1.55 μm is investigated experimentally and theoretically. An approximated equation for estimating the bending loss ratio of 1.58 to 1.55 μm is proposed, which provides good agreement with the experimental results.

VIII. Superconductive Devices

(1) Microstrip Superconducting Resonators Loaded with Yttrium Iron Garnet Single Crystals, by T. Fukusato and M. Tsutsumi (Faculty of Electrical Engineering and Computer Engineering, Kumamoto University, Kumamoto-shi, 860 Japan; Faculty of Electrical Engineering and Design, Kyoto Institute of Technology, Kyoto-shi, 606 Japan): *Trans. IEICE,* vol. J80-C-I, pp. 525–530, Nov. 1997.

A magnetically tunable microstrip superconducting resonator using an yttrium iron garnet (YIG) single crystal was demonstrated experimentally. Tunability of 200 MHz at a center frequency of 5.3 MHz was observed, and a quality factor of 965 with minimum insertion loss of 19.5 dB was measured for a half-wavelength microstrip line consisting of a YIG–YBCO–MgO composite structure. The dispersion relation of the resonator was analyzed using the spectral domain method and discussed with experimental results on the mixed states of TEM and magnetostatic wave modes. Power dependence of the characteristics is also discussed.

IX. Special Issues Related to Microwave Theory and Techniques

(1) *IEICE Trans. Electron.,* vol. E80-C, no. 1, Jan. 1997, is a special issue on Devices, Packaging Technology, and Subsystems for the Optical Access Network.

(1.1) System and Component Technologies Toward Full Access Network Opticalization (Invited), by N. Shibata and I. Yamashita (NTT Optical Network Systems Laboratories, Yokosuka-shi, 238-03 Japan): pp. 3–8.

(1.2) Fiber Access in the USA: Systems and Implications for Devices (Invited), by T. H. Wood and R. D. Feldman (Bell Laboratories-Lucent Technologies, Crawford Hill and Holmdel Laboratories, Holmdel, NJ 07733 USA): pp. 9–16.

(1.3) The Expanded Mode Laser—A Route to Low Cost Optoelectronics (Invited), by M. J. Robertson, I. F. Lealman, and J. V. Collins (BT Laboratories, Martlesham Heath, Ipswich, UK IP5 7RE): pp. 17–23.

(1.4) 1.3 μm High Performance FS–BH Laser Diodes with Waveguide Lens for Optical Access Network, by A. Takemoto, H. Higuchi, K. Shibata, M. Kato, T. Itagaki, T. Takiguchi, and Y. Hisa (Optoelectronic and Microwave Devices Laboratory, Mitsubishi Electric Corporation, Itami-shi, 664 Japan): pp. 24–29.

(1.5) Spot-Size Converter Integrated Laser Diodes (SS-LD's), by K. Itaya, Y. Tohmori, H. Okamoto, O. Mitomi, M. Wada, K. Kawano, H. Fukano, K. Yokoyama, Y. Suzaki, M. Okamoto, Y. Kondo, I. Kotaka, M. Yamamoto, M. Kohtoku, Y. Kadota, K. Kishi, Y. Sakai, H. Oohashi, and M. Nakao (NTT Opto-electronics Laboratories, Atsugi-shi, 243-01 Japan): pp. 30–40.

(1.6) High Responsivity, Low Dark Current, and Highly Reliable Operation of InGaAlAs Waveguide Photodiodes for Optical Hybrid Integration, by H. Nakamura,* M. Shishikura,* S. Tanaka,* Y. Matsuoka,* T. Ono,** T. Miyazaki,* and S. Tsuji* (*Central Research Laboratory, Hitachi, Ltd., Kokubunji-shi, 185 Japan; **Hitachi Device Engineering, Co., Ltd., 3681, Hayano, Mobara-shi, 297 Japan): pp. 41–46.

(1.7) Optical Crosstalk Reduction of 1.3 μm/1.55 μm Full-Diplex In-Line PIC Transceiver, by H. Nakajima, J. Charil, A. Leroy, D. Robein, A. Gloukhian, B. Pierre, S. Grosmaire, Y. Raffle, and J. Landreau (France Telecom-CNET, Centre Paris-B, Laboratoire de Bagneux, 196 avenue H. Ravera, BP 107, F-92225 Bagneux cedex, France): pp. 47–53.

(1.8) A Transceiver PIC for Bidirectional Optical Communication Fabricated by Bandgap Energy Controlled Selective MOVPE, by T. Takeuchi, T. Sasaki, K. Hamamoto, M. Hayashi, K. Makita, K. Taguchi, and K. Komatsu (Optoelectronics Research Laboratories, NEC Corporation, Tsukuba-shi, 305 Japan): pp. 54–61.

(1.9) Polarization Insensitive Electroabsorption Modulators for High-Speed Optical Gating, by K. Yamada, K. Nakamura, H. Murai, T. Kunii, and Y. Ogawa (Oki Electric Industry Co., Ltd., Hachioji-shi, 193 Japan): pp. 62–68.

(1.10) Integrated Tunable DBR Laser with EA-Modulator Grown by Selective Area MOVPE, by Y. Katoh, K. Yamada, T. Kunii, and Y. Ogawa (Oki Electric Industry Co., Ltd., Hachioji-shi, 193 Japan): pp. 69–73.

(1.11) An All-Optical Base Station for MMW Micro-Cell Radio Using Microwave-Optical Mixing in $LiNbO_3$ Modulators, by H. J. Thomas,* N. Imai,** and E. Ogawa** (*GSM Research Group, GSM Products Division, Motorola Ltd. 16 Euroway, Blagrove, Swindou, Wittshire, SN5 8YQ England; **ATR Optical and Radio Communications Research Laboratories, Kyoto-fu, 619-02 Japan): pp. 74–80.

(1.12) Optical Surface Mount Technology (Invited), by T. Uchida,* and O. Mikami** (*Institute of Research and Development, Tokai University, Tokyo, 151 Japan; **Faculty of Engineering, Tokai University, Hiratsuka-shi, 259-12 Japan): pp. 81–87.

(1.13) Low-Cost Hybrid WDM Module Consisting of a Spot-Size Converter Integrated Laser Diode and a Waveguide Photodiode on a PLC Platform for Access Network Systems (Invited), by N. Uchida,* Y. Yamada** Y. Hibino,** Y. Suzuki,* and N. Ishihara*** (*NTT Opto-electronics Laboratories, Atsugi-shi, 243-01 Japan; **NTT Opto-electronics Laboratories, Ibaraki-ken, 319-11 Japan NTT System Electronics Laboratories, Atsugi-shi, 243-01 Japan): pp. 88–97.

(1.14) Low Cost Optical Module Packaging Techniques for Optical Access Network Systems, by K. Kurata,* K. Yamauchi,* A. Kawatani,* A. Goto,* N. Kimura,* K. Higashikawa,* S. Dohmae,** H. Tanaka,** and S. Ishikawa* (*2nd Transmission Div., Transmission Operations Unit, NEC Corporation, Kawasaki-shi, 211 Japan NEC Engineering Corporation, Kawasaki-shi, 211 Japan): pp. 98–106.

(1.15) High Optical Coupling Scheme in LD Modules with Silicon Platform Technology, by K. Tanaka, S. Sasaki, G. Nakagawa, T. Yamamoto, K. Miura, S. Ogita, and M. Yano (Fujitsu Laboratories Ltd., Atsugi-shi, 243-01 Japan): pp. 107–111.

(1.16) Passive Aligned Hybrid Integrated WDM Transceiver Module Using Planar Lightwave Circuit Platform, by H. Okano,* I. H. Otsuki,* H. Uetsuka,* T. Teraoka,* T. Shiota,* S. Aoki,** and S. Tsuji*** (*Optoelectronic System Laboratory, Hitachi Cable, Ltd., Hitachi-shi, 319-14 Japan; **Telecommunications Division, Hitachi Ltd., Kokubunji-shi, 185 Japan Central Research Laboratory, Hitachi Ltd., Kokubunji-shi, 185 Japan): pp. 112–116.

(1.17) Present Prospect of Graded-Index Plastic Optical Fiber in Telecommunication (Invited), by E. Nihei,* T. Ishigure,** N. Tanio,** and Y. Koike** (*Faculty of Science and Technology, Keio University, Yokohama-shi, 223 Japan; **Kanagawa Academy of Science and Technology, Yokohama-shi, 236 Japan): pp. 117–122.

(1.18) Design and Fabrication of Highly-Dense Optical Components for In-Service Fiber Testing and Monitoring in Subscriber Loops, by T. Oguchi,* N. Takato,* H. Hanafusa,* N. Tomita,** Y. Enomoto,** and N. Nakao*** (*NTT Opto-electronics Laboratories, Ibaraki-ken, 319-11 Japan; **NTT Access Network Systems Laboratories, Ibaraki-ken, 319-11 Japan; ***NTT Network System Development Department, Chiba-shi, 261 Japan): pp. 123–129.

(1.19) FDM/WDM Couplers Using Silica Waveguide Deposited by APCVD, by T. Hanada,* T. Shimoda,* M. Kitamura,* and S. Nakamura** (*NEC Opto-electronics Research Labs., Kawasaki-shi, 216 Japan NEC 2nd Transmission Div., Kawasaki-shi, 211 Japan): pp. 130–133.

(1.20) $2 \times N$ Optical Splitters Using Silica-Based Planar Lightwave Circuits, by H. Uetsuka, T. Hakuta, H. Okano, N. Taketani, and T. Teraoka (Optoelectronic System Laboratory, Hitachi Cable, Ltd., Hitachi-shi, 319-14 Japan): pp. 134–138.

(1.21) Self-Aligning Optical Interconnect Scheme Using Put-in Microconnector, by T. Kato, R. J. Mizuno, and K. Iga (Precision and Intelligence Laboratory, Tokyo Institute of Technology, Yokohama-shi, 226 Japan): pp. 139–143.

(1.22) Fusion Splicing Technique for Aerial Optical Cables in Access Networks, by H. Taya, S. Yaguchi, T. Sato, and M. Yoshinuma (Precision Instruments Research & Development Dept., Fiber Optic System Division, Fujikura Ltd., Sakura-shi, 285 Japan): pp. 144–148.

(1.23) Compact Latching Type Single-Mode Fiber Switches and Their Applications in Subscriber Loop Networks, by S. Nagaoka (NTT Opto-electronics Japan): pp. 149–153.

(2) *IEICE Trans. Commun.,* vol. E79-B, no. 4, Apr. 1997, is a special issue on Optical Fibers and Their Applications.

(2.1) Recent Development of Fiber-Optic Technology (Invited), by Y. Fujii (College of Science and Technology, Nihon University, Funabashi-shi, 274 Japan): pp. 504–507.

(2.2) Low Rayleigh Scattering Silicate Glasses for Optical Fibers, by S. Sakaguchi, and S. Todoroki (NTT Opto-Electronics Laboratories, Ibaraki-ken, 319-11 Japan): pp. 508–515.

(2.3) Design of Polarization-Maintaining Optical Fiber Suitable for Thermally-Diffused Expanded Core Techniques, by H. Yokota, E. Okitsu, and Y. Sasaki (Department of Systems Engineering, Ibaraki University, Hitachi-shi, 316 Japan): pp. 516–521.

(2.4) 3-Dimensional Beam Propagation Analysis of Nonlinear Optical Fibers, by A. Niyama and M. Koshiba (Division of Electronics and Information Engineering, Hokkaido University, Sapporo-shi, 060 Japan): pp. 522–527.

(2.5) Distributed Oil Sensors by Eccentric Core Fibers, by K. Nakamura,* N. Uchino,* Y. Matsuda,* and T. Yoshino** (*Furukawa Electric Co. Yokohama R&D Laboratories, Yokohama-shi, 220 Japan; **Department of Electrical Engineering, Gunma University, Kiyu-shi, 376 Japan): pp. 528–534.

(2.6) MPO Optical Backplane Connector, by N. Shimoji (Furukawa Electric Co., Ltd., Ichihara-shi, 290 Japan): pp. 535–539.

(2.7) Pre-Connectorized High Density Optical Fiber Cable Technology, by H. Iwata, S. Tomita, S. Nagasawa, and T. Tanifuji (NTT Access Network Systems Laboratories, Ibaraki-ken, 319-11 Japan): pp. 540–550.

(2.8) A Novel Chirped Fiber Bragg Grating Utilizing Thermal Diffusion of Core Dopant, by S. Okude, T. Sakai, M. Sudoh, A. Wada, and R. Yamauchi (Fujikura Ltd., Optoelectronics Laboratory, Sakura-shi, 285 Japan): pp. 551–556.

(3) *IEICE Trans. Commun.*, vol. E80-13, no. 5, May 1997, is special issue on EMC/EMI Problems in Microwave Frequency Range.

(3.1) Dosimetric Evaluation of Handheld Mobile Communications Equipment with Known Precision (Invited), by N. Kuster, R. Kastle, and T. Schmid (Swiss Federal Institute of Technology (ETH), CH-8092 Zurichi, Switzerland): pp. 645–652.

(3.2) Current Topics of Microwave EMI Antennas and Measurements (Invited), by A. Sugiura,* N. Kuwabara,** and T. Iwasaki*** (*Communications Research Laboratory, Koganei-shi, 184 Japan; **NTT Multimedia Network Laboratory, Musashino-shi, 180 Japan; ***University of Electro-Communications, Chofu-shi, 182 Japan): pp. 653–662.

(3.3) Automotive Radio Noise in Lower Frequency Microwave Bands (1–3 GHz) Measured in a Van Running in an Urban Area, by Y. Yamanaka and A. Sugiura (Communications Research Laboratory, Ministry of Posts and Telecommunications, Koganei-shi, 184 Japan): pp. 663–669.

(3.4) Modeling of Microwave Oven Interference Using Class-A Impulsive Noise and Optimum Reception, by H. Kanemoto, S. Miyamoto, and N. Morinaga, (Graduate School of Engineering, Osaka University, Suita-shi, 565 Japan): pp. 670–677.

(3.5) Crosstalk Analysis of High-Speed Logic Circuits, by M. Omid,* Y. Kami,**, and M. Hayakawa* (*Department of Electronic Engineering, The University of Electro-Communications, Tokyo, 182 Japan; **Department of Communication and System Engineering, The University of Electro-Communications, Tokyo, 182 Japan): pp. 678–685.

(3.6) Measurement of Electromagnetic Field Distribution in Waveguide Based on Analogy Between H—Plane Waveguide—and Trough-Type Planar Circuit, by T. Anada, T. Hiraoka, and Jui-Pang Hsu (Department of Electrical Engineering, Kanagawa University, Yokohama-shi, 221 Japan): pp. 686–691.

(3.7) Linearly Polarized Conical Log-Periodic Spiral Antenna for Microwave EMC/EMI Measurement, by R. Wakabayashi,* K. Shimada,* H. Kawakami,** and G. Sato** (*Department of Electrical Engineering, Tokyo Metropolitan College of Aeronautical Engineering, Tokyo, 116 Japan Laboratory Antenna Giken Co., Ltd., Omiya-shi, 330 Japan): pp. 692–698.

(3.8) Reduction of Coupling Between Two Wire Antennas Using a Slot, by T. Morioka and K. Hirasawa (Microwave Control Laboratory, Institute of Information Sciences and Electronics, University of Tsukuba Tsukuba-shi, 305 Japan): pp. 699–705.

(3.9) Electromagnetic Sealing for Helical Heater Terminal Used in Combination Microwave Oven, by T. Kubota,* H. Nakano,* K. Koshiji,* E. Shu,* I. Kikuchi,** and K. Sugimoto*** (*Faculty of Science and Technology, Science University of Tokyo, Noda-shi, 278 Japan; **Hitachi Hometec, Ltd., Kashiwa-shi, 277 Japan ***General Research of Electronics, Inc., Tokyo, 106 Japan): pp. 706–708.

(3.10) Measurement of Power Absorption by Human Model in the Vicinity of Antennas, by Q. Chen,* T. Shinohe**, K. Igari,* and K. Sawaya* (*Faculty of Engineering, Tohoku University, Sendai-shi, 980-77 Japan Hokkaido Electric Power Co., Inc., Sapporo-shi, 060 Japan): pp. 709–711.

(4) *IEICE Trans. Electron.*, vol. E80-C, no. 5, May 1997, is special issue on Photonic Integrated Circuits.

(4.1) Silica-Based Planar Lightwave Circuits for WDM Systems (Invited), by Y. Inoue, K. Kato, K. Okamoto, and Y. Ohmori (NTT Opto-electronics Laboratories, Ibaraki-ken, 319-11 Japan): pp. 609–618.

(4.2) Wavelength Division Multi/Demultiplexer with Arrayed Waveguide Grating, by H. Uetsuka, K. Akiba, K. Morosawa, H. Okano, S. Takasugi, and K. Inaba (Optoelectronic System Laboratory, Hitachi Cable, Ltd., Hitachi-shi, 319-14 Japan): pp. 619–624.

(4.3) Analysis and Design of Low Loss and Low Mode-Shift Integrated Optical Waveguides Using Finite-Difference Time-Domain Method, by T. Doi, A. Iwata, and M. Hirose (Faculty of Engineering, Hiroshima University, Higashi-Hiroshima-shi, 739 Japan): pp. 625–631.

(4.4) Temperature-Independent Narrow-Band Optical Filter by an Athermal Waveguide, by Y. Kokubun, S. Yoneda, and H. Tanaka (Department of Electrical and Computer Engineering, Faculty of Engineering, Yokohama National University, Yokohama-shi, 240 Japan): pp. 632–639.

(4.5) Wide-Angle Coupling to Multi-Mode Interference Devices—A Novel Concept for Compacting Photonic Integrated Circuits, by M. Bouda, Y. Nakao, and K. Tada (Department of Electronic Engineering, University of Tokyo, Tokyo, 113 Japan): pp. 640–645.

(4.6) Phased-Array-Based Photonic Integrated Circuits for Wavelength Division Multiplexing Applications, by A. A. M. (Toine) Staring,* and M. K. Smit** (*Philips Optoelectronics Centre, Prof. Holstlaan 4, 5656 AA Eindhoven, The Netherlands; **Department of Electrical Engineering, Delft University of Technology, 2600 GA Delft, The Netherlands): pp. 646–653.

(4.7) In-Plane Bandgap Energy Controlled Selective MOVPE and Its Applications to Photonic Integrated Circuits, by T. Sasaki, M. Yamaguchi, K. Komatsu, and I. Mito (Opto-electronics Research Laboratories, NEC Corporation, Tsukuba-shi, 305 Japan): pp. 654–663.

(4.8) Ultra-Low Threshold Current Vertical-Cavity Surface-Emitting Lasers for Photonic Integrated Circuits, by D. G. Deppe, D. L. Huffaker, H. Deng, Q. Deng, and T.-H. Oh (Microelectronics Research Center, Department of Electrical and Computer Engineering, The University of Texas at Austin, Austin, Texas 78712-1084, USA): pp. 664–674.

(4.9) Characterization of Butt-Joint InGaAsP Waveguides and Their Application to 1310 nm DBR-Type MQW Gain-Clamped Semiconductor Optical Amplifiers, by J. J. M. Binsma, P. J. A. Thijs, T. van Dongen, E. J. Jansen, A. A. M. Staring, G. N. van den Hoven, and L. F. Tiemeijer (Philips Optoelectronics Centre, Prof. Holstlaan 4 (WY62), 5656 AA Eindhoven, The Netherlands): pp. 675–681.

(4.10) Direct Wafer Bonding Technique Aiming for Free-Material and Free-Orientation Integration of Semiconductor Materials, by Y. Okuno, K. Uomi, M. Aoki, and T. Tsuchiya (Central Research Laboratory, Hitachi Ltd., Kokubunji-shi, 185 Japan): pp. 682–688.

(4-11) 16 × 16 Two-Dimensional Optoelectronic Integrated Receiver Array for Highly Parallel Interprocessor Networks, by H. Yano,* S. Sawada,* K. Doguchi**, T. Kato,* and G. Sasaki* (*Optoelectronics Sumiden Laboratory, RWCP, c/o Optoelectronics R&D Laboratories, Sumitomo Electric Industries, Ltd., Yokohama-shi, 244 Japan; **Optoelectronics R&D Laboratories, Sumitomo Electric Industries, Ltd., Yokohama-shi, 244 Japan): pp. 689–694.

(4.12) High Speed Monolithically Integrated p-i-n/HBT Photoreceivers, by K.-C. Syao, A. L. Gutierrez-Aitken,† K. Yang, X. Zhang, G. I. Haddad, and P. K. Bhattacharya (Solid State Electronics Laboratory, Department of Electrical Engineering and Computer Science, The University of Michigan; †Presently at TRW, Redondo Beach, California): pp. 695–702.

(4.13) Isolator-Free DFB-LD Module with TEC Control Using Silicon Waferboard, by K. Terada, S. Sasaki, K. Tanaka, T. Yamamoto, T. Ikeuchi, K. Miura, and M. Yano (Fujitsu Laboratories Ltd., Atsugi-shi, 243-01 Japan): pp. 703–706.

(5) *IEICE Trans. Electron.,* vol. E80-C, no. 6, June 1997, is special issue on Microwave and Millimeterwave High-power Devices.

(5.1) Considerations for High-Efficiency Operation of Microwave Transistor Power Amplifiers (Invited), by Y. Takayama (Semiconductor Group, NEC Corporation, Kawasaki-shi, 211 Japan): pp. 726–733.

(5.2) Large-Signal Analysis of Power MOSFETs and Its Application to Device Design, by N. Matsuno,* H. Yano,* I. Y. Suzuki,* T. Inoue**, T. Toda**, Y. Kose**, Y. Takayama,*** and K. Honjo* (*Opto-Electronics Research Laboratories, NEC Corporation, Tsukuba-shi, 305 Japan; **Compound Semiconductor Device Division, NEC Corporation, Kawasaki-shi, 211 Japan; ***Semiconductor Group, NEC Corporation, Kawasaki-shi, 211 Japan): pp. 734–739.

(5.3) High Efficiency AlGaAs/GaAs Power HBTs at a Low Supply Voltage for Digital Cellular Phones, by T. Shimura,* T. Miura,* Y. Uneme,* I. H. Nakano,** R. Hattori,** M. Otsubo,* K. Mori,*** A. Inoue,* and N. Tanino* (*Optoelectronic and Microwave Devices Laboratory, Mitsubishi Electric Corporation, Itami-shi, 664 Japan; **High Frequency and Optical Semiconductor Division, Mitsubishi Electric Corporation, Itami-shi, 664 Japan; ***Information Technology R&D Center, Mitsubishi Electric Corporation, Ofuna-shi, 247 Japan): pp. 740–745.

(5.4) Power Heterojunction FET with High Breakdown Voltage for X- and Ku-Band Applications, by Y. Okamoto,* K. Matsunaga,* M. Kanamori,* M. Kuzuhara,** and Y. Takayama*** (*Kansai Electronics Research Laboratories, NEC Corporation, Otsu-shi, 520 Japan; **ULSI Device Development Laboratories, NEC Corporation, Otsu-shi, 520 Japan; ***Semiconductor Group, NEC Corporation, Kawasaki-shi 211 Japan): pp. 746–750.

(5.5) A Small-Sized 10 W Module for 1.5 GHz Portable DMCA Radios Using New Power Divider/Combiner, by M. Maeda, M. Nakamura, S. Morimoto, H. Masato, and Y. Ota (Electronics Research Laboratory, Matsushita Electronics Corporation, Moriguchi-shi, 570 Japan): pp. 751–756.

(5.6) MMIC/Super-MIC/MIC-Combined *C*- to *Ku*-Band 2W Balanced Amplifier Multi-Chip Module, by Y. Itoh,* M. Nii,** N. Takeuchi,** Y. Tsukahara,*** and H. Kurebayashi**** (*Information Technology R&D Center, Mitsubishi Electric Corporation, Kamakura-shi, 247 Japan; **Communication Equipment Works, Mitsubishi Electric Corporation, Amagasaki-shi, 661 Japan; ***Optoelectronic and Microwave Devices Laboratory, Mitsubishi Electric Corporation, Itami-shi, 664 Japan; ****Planning and Administration Department, Mitsubishi Electric Corporation, Tokyo, 100 Japan): pp. 757–762.

(5.7) A Low Distortion and High Efficiency Paralleled Power Amplifier Without an Isolator in Wide Range of Load Impedances, by H. Ikeda,* H. Kosugi,** and T. Uwano** (*Communication Systems Division, Matsushita Communication Industrial Co., Ltd., Yokohama-shi, 223 Japan; **Device Engineering Development Center, Matsushita Electric Industrial Co., Ltd., Kadoma-shi, 571 Japan): pp. 763–767.

(5.8) A Low Distortion Technique for Reducing Transmitter Intermodulation, by H. Hayashi and M. Muraguchi (NTT Wireless Systems Laboratories, Yokosuka-shi, 239 Japan): pp. 768–774.

(5.9) Improvement of Adjacent Channel Leakage Power and Intermodulation Distortion by Using a GaAs FET Linearizer with a Large Source Inductance, by K. Mori,* K. Yamauchi,* M. Nakayama,* Y. Itoh,* T. Takagi,* and H. Kurebayashi** (*Information Technology R&D Center, Mitsubishi Electric Corporation, Kamakura-shi, 247 Japan; **Electronic Products & Systems Group, Mitsubishi Electric Corporation, Tokyo, 100 Japan): pp. 775–781.

(5.10) Compensation of Nonlinear Distortion During Transmission Based on the Adaptive Predistortion Method, by T. Matsuoka,* M. Orihashi,* M. Sagawa,* H. Ikeda,** and K. Misaizu** (*Mobile Communication Research Laboratory, Matsushita Research Institute Tokyo, Inc., Kawasaki-shi, 214 Japan; **Communication Systems Division, Matsushita Communication Industrial Co., Ltd., Yokohama-shi, 223 Japan): pp. 782–787.

(5.11) A Resonant-Type GaAs Switch IC with Low Distortion Characteristics for 1.9 GHz PHS, by A. Kameyama,* K. K. Kawakyu,* Y. Ikeda,* M. Nagaoka,* K. Ishida,** T. Nitta,* I. M. Yoshimura,* Y. Kitaura,* and N. Uchitomi* (*Research and Development Center, Toshiba Corporation, Kawasaki-shi, 210 Japan; **Semiconductor System Engineering Center, Toshiba Corporation, Yokohama-shi, 247 Japan): pp. 788–793.

(5.12) Gate Current Control Method by Pull-Down FET's for 0–28 dB GaAs Variable Attenuator in Direct-Conversion Modulator IC for 1.9 GHz PHS, by T. Sasaki,* S. Otaka,** T. Maeda,** T. Umeda,** K. Nishihori,* A. Kameyama,** M. Hirose,* Y. Kitaura,* and N. Uchitomi* (*ULSI Research Laboratories, Toshiba Corporation, Kawasaki-shi, 210 Japan; **Research and Development Center, Toshiba Corporation, Kawasaki-shi, 210 Japan): pp. 794–799.

(5.13) High Efficient Spatial Power Combining Utilizing Active Integrated Antenna Technique, by S. Kawasaki (Department of Communications Engineering, Tokai University, Hiratsuka-shi, 259-12 Japan): pp. 800–805.

(6) *IEICE Trans. Electron.,* vol. E80-C, no. 10, Oct. 1997, is a special issue on Basic Properties and Applications of Superconductive Electron Devices.

(6.1) A High-T_c, Superconductor Josephson Sampler (Invited), by M. Hidaka, T. Satoh, H. Terai, and S. Tahara (Fundamental Research Laboratories, NEC Corporation, Tsukuba-shi, 305 Japan): pp. 1226–1232.

(6.2) Investigation of High-T_c, Single Flux Quantum Logic Gates (Invited), by K. Saitoh* and H. Fuke** (*Superconductivity Research Laboratory, International Superconductivity Technology Center, Tokyo, 135 Japan; **Advanced Research Laboratory, Toshiba Corporation, Kawasaki-shi, 210 Japan): pp. 1233–1239.

(6.3) Recent Development of High T_c dc SQUID Magnetometer (Invited), by K. Enpuku (Department of Electronic Device Engineering, ISEE, Kyushu University, Hakozaki, Fukuoka-shi, 812 Japan): pp. 1240–1246.

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(6.9) Millimeter and Submillimeter-Wave Phase-Locking in High-T_c, Josephson Junction Arrays, by K. Lee,* I. Iguchi,* K. Y. Constantinian,** G. A. Ovsyannikov,** J. Kim,*** and K. Y. Kang*** (*Department of Applied Physics, Tokyo Institute of Technology, Tokyo, 152 Japan; **Institute of Radioengineering and Electronics RAS, Mokhovaya 11, Moscow, 103907, Russia; ***Research Department, Electronic & Telecommunications Research Institute, Daejon, Korea): pp. 1275–1281.

(6.10) Ultrafast Optical Response and Terahertz Radiation from High-T_c, Superconductor (Invited), by M. Hangyo,* N. Wada,* M. Tonouchi,* M. Tani,** and K. Sakai** (*Research Center for Superconducting Materials and Electronics, Osaka University, Suita-shi, 565 Japan; **Kansai Advanced Research Center, Communications Research Laboratory, Kobe-shi, 651-24 Japan): pp. 1282–1290.

(6.11) Analysis by I–V Curves for Intrinsic Josephson Junctions of $Tl_2Ba_2CaCu_2O_x$ Thin Films on MgO Substrates (Invited), by S. Yoshikawa, M. Nemoto, K. Shimaoka, I. Yoshida, and Y. Yoshisato (Tsukuba Research Center, SANYO Electric Co., Ltd., Tsukuba-shi, 305 Japan): pp. 1291–1296.

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(6.13) Ferroelectric Field-Control in $Pb(Zr_{0.52}Ti_{0.48})O_3/(Y_{0.6}Pr_{0.4})Ba_2Cu_3O_y$ Heterostructures and Their Memory, by S. Hontsu,* M. Nakamori,** H. Tabata,*** J. Ishii,* and T. Kawai*** (*Faculty of Biology Oriented Science and Technology, Kinki University, Wakayama-ken, 649-64 Japan; **Department of Electrical Engineering, Kumano Technical College, Kumano-shi, 519-43 Japan; ***Institute of Scientific and Industrial Research, Osaka University, Ibaraki-shi, 567 Japan): pp. 1304–1309.

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(7.1) Stochastic Integral Equation for Rough Surface Scattering (Invited), by H. Ogura,*† and Z. L. Wang**†† (*Department of Electronics and Communication, Kyoto University, Kyoto-shi, 606 Japan; **Radio Atmospheric Science Center, Kyoto University, Uji-shi, 611 Japan; †Presently, with the Faculty of Biophysics, Department of Information and Electronic System, Kinki University; ††Presently, with the Communications Research Laboratory, Ministry of Posts and Telecommunications): pp. 1337–1342.

(7.2) Microwave Inverse Scattering: Quantitative Reconstruction of Complex Permittivity for Different Applications (Invited), by C. Pichot,* P. Lobel,* C. Dourthe,** L. Blanc-Feraud,*** and M. Barlaud*** (*Laboratoire d'Electronique, Antennes et Telecommunications, UNSA/CNRS, Bat. 4, 250 rue Albert Einstein, 06560 Valbonne, France; **Centre d'Enseignement et de Recherche

en Mathematiques, Informatique et Calcul Scientifique/INRIA, 2004 route des Lucioles, B.P. 93, 06902 Sophia Antipolis, France; ***Laboratoire d'Informatique, Signaux et Systemes de Sophia Antipolis, UNSA/CNRS, Bat. 4, 250 rue Albert Einstein, 06560 Valbonne, France): pp. 1343–1348.

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(7.4) A Sparse-Matrix/Canonical Grid Method for Analyzing Microstrip Structures (Invited), by C. H. Chan,*** C. M. Lin,*** L. Tsang,** and Y. F. Leung* (*Department of Electronic Engineering, City University of Hong Kong, 83 Tat Chee Ave, Kowloon, Hong Kong; **Department of Electrical Engineering, Box 352500, University of Washington, Seattle, WA 98195-2500, USA): pp. 1354–1359.

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(7.6) An Incremental Theory of Diffraction for Objects with Local Cylindrical Shape (Invited), by R. Tiberio,* S. Maci,** and A. Toccafondi* (*College of Engineering, University of Siena, Via Roma 56, 53100 Siena, Italy; **Department of Electronic Engineering, University of Florence, Via S. Marta 3, 50139 Florence, Italy): pp. 1367–1373.

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(7.8) Scattering and Diffraction of a Plane Wave by a Randomly Rough Half-Plane: Evaluation of the Second-Order Perturbation, by Y. Tamura, J. Nakayama, and K. Komori (Faculty of Engineering and Design, Kyoto Institute of Technology, Kyoto-shi, 606 Japan): pp. 1381–1387.

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(7.14) Analysis of Scattering of Waves by General Bianisotropic Slabs, by K. Matsumoto,* K. Rokushima,* and J. Yamakita** (*Faculty of Engineering, Osaka Sangyo University, Daito-shi, 574 Japan; **Faculty of Information Engineering, Okayama Prefectural University, Soujya-shi, 719-11 Japan): pp. 1421–1427.

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