

## Japanese Aerospace Literature This month: *Antenna Design*

**A93-44761 High-Tc superconducting small antennas.** K. ITOH, O. ISHII, Y. NAGAI, N. SUZUKI, Y. KIMACHI, and O. MICHIKAMI (NTT Corp., Interdisciplinary Research Labs., Tokai, Japan). *IEEE Transactions on Applied Superconductivity* (ISSN 1051-8223), Vol. 3, No. 1, pt. 4, March 1993, pp. 2836-2839. (1992 Applied Superconductivity Conference, Chicago, IL, Aug. 23-28, 1992, Proceedings, pt. 3. A93-44612 18-33). 14 Refs.

The authors describe the designs of and report experimental results for one- and two-element high-Tc superconducting small antennas composed of self-resonant helical radiators and quarter-wave matching circuits. A 500-MHz-band antenna using a  $\lambda/40$  ( $\lambda$  is the free-space wavelength) radiator fabricated with Bi(Pb)SrCaCuO bulk realized a gain of  $-1.2$  dBi, which indicates that this antenna achieves a high frequency of 70 percent. A 900-MHz-band two-element array antenna using  $\lambda/20$  radiator with a  $\lambda/11$  element spacing was designed to obtain a superdirective radiation pattern. The array antenna thus fabricated with YBaCuO bulk realized both a higher efficiency than a Cu antenna and a unidirectional radiation pattern. Furthermore, by adopting EuBaCuO thin-film meander lines as the matching circuit, the total length could be reduced to about 1/4 that of an antenna using a linear circuit. (Author)

**A93-43841 Planar antenna excited by electromagnetically coupled coplanar waveguide.** E. T. RAHARDJO, S. KITAO, and M. HANEISHI (Saitama Univ., Urawa, Japan). *Electronics Letters* (ISSN 0013-5194), Vol. 29, No. 10, May 13, 1993, pp. 870-872. 4 Refs.

Planar antennas fed by electromagnetically coupled coplanar waveguide (CPW) have been fabricated on a single layer substrate with various thicknesses, and been studied experimentally. To suppress the spurious mode due to the parallel plate structure in the antenna system, short pins are inserted near the feeding point of the coplanar line. The measurement results of this antenna demonstrated high performance in both return loss and radiation pattern. (Author)

**A93-43834 Leaky NRD guide fed microwave planar antenna.** K. MAAMRIA, Y. WAGATSUMA, and T. YONEYAM (Tohoku Univ., Sendai, Japan). *Electronics Letters* (ISSN 0013-5194), Vol. 29, No. 10, May 13, 1993, pp. 836-838. 4 Refs.

A novel and unique application of leaky waveguides as feeding systems for microwave planar antennas is presented. A new leaky nonradiative dielectric (NRD) guide based on a grating structure is proposed, and a planar array slot antenna using this leaky waveguide is constructed and measured at 23 GHz. (Author)

**A93-40333 Design method for an offset dual-shaped reflector antenna with high efficiency and an elliptical beam.** K. AOKI (Mitsubishi Electric Corp., Communications Equipment Works, Amagasaki, Japan); S. MAKINO, T. KATAGI (Mitsubishi Electric Corp., Electro-Optics & Microwave Systems Lab., Kamakura, Japan); and K. KAGOSHIMA (NTT, Radio Communication Systems Labs., Yokosuka, Japan). *IEEE Proceedings, Part H—Microwaves, Antennas and Propagation* (ISSN 0950-10EX), Vol. 140, No. 2, April 1993, pp. 121-128. 12 Refs.

A newly developed method of design for a shaped reflector antenna is described. A conventional quadratic reflector configuration is assumed; the reflectors are then modified to yield the desired aperture shape and field distribution by introducing shaping functions. This method is useful for designing antennas with an arbitrary shaped beam, such as an elliptical-beam antenna, and has been verified through a  $4.7 \text{ m} \times 2.3 \text{ m}$  dual-band earth-station antenna for the Japanese domestic satellite system CS. The measured aperture efficiency is more than 76 percent, and the ratio of the major and minor axes of the elliptical beam is 2:1. (Author)

**A93-37435 Design and development of a deployable mesh antenna for MUSES-B spacecraft.** M. C. NATORI and TADASHI TAKANO (Inst. of Space and Astronautical Science, Sagami, Japan); and TOSHIO INOUE and TAKAHIKO NODA (Mitsubishi Electric Corp., Kamakura Works, Japan). *AIAA, ASME, ASCE, AHS, and ASC, Structures, Structural Dynamics and Materials Conference*, 34th and AIAA and ASME, Adaptive Structures Forum, La Jolla, CA, Apr. 19-22, 1993. 10 pp. 11 Refs.

A precise deployable antenna structure is necessary in relatively near future for various missions. Requirement of high accuracy of antenna surface conflicts with that of good packaging efficiency, and to solve this conflict is important. Design and development of a mesh antenna system with six extendible masts is introduced to provide well balanced performance for both simple deployment and good surface accuracy. Various error sources affected to surface accuracy are studied both analytically and experimentally. (Author)

**A93-32824 Self-complementary antennas.** YASUTO MUSHIAKE. *IEEE Antennas and Propagation Magazine* (ISSN 1045-9243), Vol. 34, No. 6, Dec. 1992, pp. 23-29. 33 Refs.

A summary of a series of studies of self-complementary antennas and their development is presented. Dual structures and their electromagnetic fields are discussed. Attention is given to input impedances for complementary structures and the constant-impedance properties of self-complementary structures. Multi-terminal, three-dimensional, and stacked

self-complementary antennas are discussed. Developmental studies of self-complementary antennas are reviewed.

**A93-32822 Feed circuits of double-layered self-diplexing antenna for mobile satellite communications.** MASAYUKI NAKANO and HIROYUKI ARAI (Yokohama National Univ., Japan); WATARU CHUJO and MASAYUKI FUJISE (ATR Optical and Radio Communications Research Labs., Kyoto, Japan); and NAOHISA GOTO (Tokyo Inst. of Technology, Japan). *IEEE Transactions on Antennas and Propagation* (ISSN 0018-926X), Vol. 40, No. 10, Oct. 1992, pp. 1269-1271. 6 Refs.

The analysis presently conducted for the feed circuits of a mobile satellite communications double-layered self-diplexing antenna shows the possibility of reducing the weight of a self-diplexing antenna by allowing a large degree of internal isolation between transmission and reception. Internal isolation is heavily dependent on the configuration and errors of the antenna's feed circuits, and attention is accordingly given to the feed circuits of two- and four-point feeds for the antenna by using the cavity model of microstrip elements.

**A93-22500 Determination of antenna factors using a three-antenna method at open-field test site.** HIROSHI MASUZAWA, TERUO TEJIMA, KATSUSHIGE HARIMA, and TAKAO MORIKAWA. *Communications Research Laboratory, Review* (ISSN 0914-9279), Vol. 38, No. 3, Sept. 1992, pp. 173-180. In Japanese. 4 Refs.

Recently NIST has used the three-antenna method for calibration of the antenna factor of an antenna used for EMI measurements. This method does not require the specially designed standard antennas which are necessary in the standard field method or the standard antenna method, and can be used at an open-field test site. This paper theoretically and experimentally examines the measurement errors of this method and evaluates the precision of the antenna-factor calibration. It is found that the main source of the error is the non-ideal propagation characteristics of the test site, which should therefore be measured before the calibration. The precision of the antenna-factor calibration at the test site used in these experiments, is estimated to be 0.5 dB. (Author)

**A93-28875 A high-speed numerical analysis technique for millimetre wave aperture antennae.** MASAMITSU NAKAJIMA and PAUL R. WINNING (Kyoto Univ., Japan). *Kyoto University, Faculty of Engineering, Memoirs* (ISSN 0023-6063), Vol. 54, No. 4, Oct. 1992, pp. 279-298. Research supported by MOESC and Japan Atomic Energy Research Inst. 7 Refs.

A numerical computation method is proposed which is suitable for the analysis of aperture antennas with complicated field distributions, such as those used for electron cyclotron resonance heating. In accordance with the method, the aperture is divided into a number of small regularly shaped areas, so that some known functions can be used to obtain analytical radiation patterns from each subaperture. The radiation pattern is given as the sum of the contributions of each subaperture. Results obtained for a whispering gallery mode antenna are presented as an example.

**N93-20447 Research on beam compression technology (Bimu asshuku gijutsu no kenkyuu).** TOSHIHIRO SEZAI and YUUJI OOSAWA. *National Space Development Agency, Ibaraki (Japan). Specific Equipment Lab. In its Research and Development Activities of the Tsukuba Space Center*, pp. 169-172 (SEE N93-20410 07-12).

An overview on the verification of the fundamental principles of beam compression technology is presented. The principle of multiplication type beam compression are outlined. Beam compression was verified by receiving RF (Radio Frequency) waves rotating an antenna system around the main antenna axis in two test configurations with different distance between main and reference antennas. (Author)

**N93-20446 Research on phased array antenna (Fazudare antena no kenkyuu).** TONEO KAWANISHI and YASUO TAMAI. *National Space Development Agency, Ibaraki (Japan). Specific Equipment Lab. In its Research and Development Activities of the Tsukuba Space Center*, pp. 165-168 (SEE N93-20410 07-12).

An overview of the research on the applicable missions and element technologies of Active Phased Array Antenna (APAA) is presented. Applicable areas of APAA were studied and shown. Comparison of APAA with an existing antenna system was conducted in performances and phase errors, taking inter satellite communication antenna (aperture diameter 10 m) as an example. Element technologies for major structural elements were studied and elements which necessitate development most were determined to be beam control, RF (Radio Frequency) (Module), and failure diagnosis sections. (Author)

**N93-20429 Research on HOPE communication and data processing equipment (HOPE tsuushin deta shori kiki no kenkyuu).** SATORU YAMAMOTO and TOSHIO KIKUCHI. *National Space Development Agency, Ibaraki (Japan). Common Equipment Lab. In its Research and Development Activities of the Tsukuba Space Center*, pp. 89-92 (SEE N93-20410 07-12).

An overview of the research on heat-resisting antenna is presented. Candidate heat-resisting antennas which were selected as the result of review on seven kinds of antenna are the antennas of micro strip, cavity, and horn types. Heat resistance characteristics of electric power supplying section (connec-

tors) of heat-resisting antenna were studied. Heat cycling test and heat shock tests were conducted on the subject plugs and it was confirmed that they can be usable at  $-80^{\circ}\text{C}$  to  $+200^{\circ}\text{C}$  against  $-65^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  for the existing plugs. Fundamental electric data such as antenna pattern were acquired mating trial produced components simulating electric characteristics of heat-resisting antenna and trial-produced ceramic tiles. (Author)

**A93-24425 Two-element superdirective array antenna composed of high-Tc superconducting small helical radiators.** KEIICHIRO ITOH, OSAMU ISHII, YASUHIRO NAGAI, NAOBUMI SUZUKI, YOSHIHIRO KIMACHI, and OSAMU MICHIKAMI (NTT, Interdisciplinary Research Labs., Tokai, Japan). *Journal of Superconductivity* (ISSN 0896-1107), Vol. 5, No. 5, Oct. 1992, pp. 485-490. 18 Refs.

This paper describes the design and reports experimental results for a two-element superdirective array antenna fabricated with YBaCuO superconducting material. 0.05-wavelength helical radiators and quarter-wave matching and branch circuits were designed for an array antenna with a 0.09- $\lambda$  radiator spacing, to obtain a superdirective radiation pattern at 900 MHz. The array antenna thus fabricated realized good impedance matching and higher radiation efficiency than a Cu antenna, and a unidirectional radiation pattern at 80 K and around 900 MHz. (Author)

**A93-18070 Thin-film long-wire antenna for 10.6-microns CO<sub>2</sub> laser radiation.** TAKASHI SHIMIZU and YOSHIMIZU YASUOKA (National Defense Academy, Yokosuka, Japan); KENJI GAMO (Osaka Univ., Toyonaka, Japan); and SUSUMU NAMBA (Nagasaki Inst. of Applied Science, Japan). *Japanese Journal of Applied Physics, Part 1* (ISSN 0021-4922), Vol. 31, No. 10, Oct. 1992, pp. 3359-3361. 8 Refs.

Thin-film warm carrier devices which had 100-, 400- and 450-microns-long thin-film antennas were fabricated, and antenna properties at CO<sub>2</sub> laser frequency were investigated. It was found that the fabricated thin-film antenna works as a long-wire antenna with electrical loss for CO<sub>2</sub> laser radiation. (Author)

**A92-55800 Study of microsat communication system.** K. KONDO, Y. HASHIMOTO, R. SUZUKI, M. TANAKA, and T. IKEGAMI (Communications Research Laboratory, Koganei, Japan); T. OBUCHI, O. NAKAGAWA, and M. MATSUI (NEC Corp., Tokyo, Japan). *IAF, International Astronautical Congress*, 43rd, Washington, Aug. 28-Sept. 5, 1992, pp. 7, 3 Refs.

Possible applications of microsatellites are briefly reviewed, and a simple microsatellite communication network is proposed. The general design of the proposed microsatellite communication system is discussed, with attention given to the radio link for ground stations, intersatellite radio link, conceptual design of the satellite bus system, microsatellite antenna design, and design of the store and forward transponder.

**A92-52084 Antenna pointing control system using a LQG controller for a large antenna reflector.** MASAZUMI UEBA (NTT, Radio Communication Systems Laboratories, Yokosuka, Japan). IN: *1992 AIAA/AAS Astrodynamics Conference*, Hilton Head Island, SC, Aug. 10-12, 1992, Technical Papers (A92-52051 22-13). Washington, American Institute of Aeronautics and Astronautics, 1992, pp. 300-306. 7 Refs.

This paper describes an antenna pointing control system using a Linear Quadratic Gaussian (LQG) controller for a 10 m class antenna reflector. The control performances of two regulators are investigated from the viewpoint of pointing accuracy and shape accuracy. The effects of the flexibility of the antenna reflector and the uncertainties of the disturbance torque on those accuracies are clarified. (Author)

**A92-50996 Analysis of slot coupled, circular microstrip patch antennas.** C. BAUMER (ATR Optical and Radio Communications Research Laboratories, Kyoto, Japan). *Electronics Letters* (ISSN 0013-5194), Vol. 28, No. 15, July 16, 1992, pp. 1454, 1455. 7 Refs.

An approach analogous to a full-wave moment method solution is proposed for the analysis of slot-coupled circular patch elements. The cavity model is used to describe the principal behavior of the patch element.

**A92-48321 Characteristics of small-aperture, single-layered, radial-line slot antennas.** M. TAKAHASHI, J. TAKADA, M. ANDO, and N. GOT, (Tokyo Institute of Technology, Japan). *IEE Proceedings, Part H—Microwaves, Antennas and Propagation* (ISSN 0950-107X), Vol. 139, No. 1, Feb. 1992, pp. 79-83. 13 Refs.

A radial-line slot antenna (RLSA) is a high-efficiency planar array. A double-layered radial line and uniform slot length have been adopted in conventional RLSAs. A single-layered RLSA is much simpler in structure, but the slot length must be varied to synthesize uniform aperture illumination. Theoretical methods for the slot design are proposed. The paper presents excellent characteristics of single-layered RLSAs of small sizes (0.25-0.60 m diameter) and confirms the design. These are now commercialized for 12 GHz band DBS reception. (Author)

**A92-48228 Evaluation of surface clutter for the design of the TRMM spaceborne radar.** HIROSHI HANADO and TOSHIO IHARA (Communications Research Laboratory, Kashima, Japan). *IEEE Transactions on Geoscience and Remote Sensing* (ISSN 0196-2892), Vol. 30, No. 3, May 1992, p. 444-453. 18 Refs.

A quantitative examination is made of surface clutter interference on spaceborne rain radar due to antenna sidelobes, with a view to the clarification of antenna design criteria. The intensities of both rain echo and sea

clutter are numerically evaluated with suitable precipitation and sea-surface scattering models, as well as a realistic phased-array antenna pattern. Results indicate that a region exists just above the sea surface where clutter masks the backscattered power from the rain. For a 17-deg incidence angle, this region extends to an altitude of about 1.2 km.

**A92-45971 A reflection cancelling slot set in a linearly polarized radial line slot antenna.** JUN-ICHI TAKADA, MAKOTO ANDO, and NAOHISA GOTO (Tokyo Institute of Technology, Japan). *IEEE Transactions on Antennas and Propagation* (ISSN 0018-926X), Vol. 40, No. 4, April 1992, pp. 433-438. 12 Refs.

A radial line slot antenna (RLSA) is a high-gain and high-efficiency planar antenna. Circularly polarized RLSA (CP-RLSA) has realized the highest antenna efficiency of 85 percent to 60 cm phi DBS antenna. A linearly polarized RLSA (LP-RLSA) is also attractive for applications of various subscriber radio systems. However, the slot arrangement for linear polarization gives rise to serious reflection from slots, which disturbs the normal antenna operation. A new slot design of LP-RLSA is presented where reflection canceling slots are added to the conventional ones; four slots form one slot set as a unit radiator of linear polarization. The experiments confirm the design: the antenna return-loss is improved from  $-2$  to  $-10$  dB. The antenna efficiency of 48 and 54 percent are measured for 400 and 600 mm phi antennas, respectively. This is the first report of the normal operation of LP-RLSA's. (Author)

**A92-43936 High Tc superconducting active antenna with reflector.** TOSHIRO OHNUMA and YUKI TANAKA (Tohoku University, Sendai, Japan). *IEEE Transactions on Applied Superconductivity* (ISSN 1051-8223), Vol. 2, No. 2, June 1992, pp. 113-115. 5 Refs.

High Tc superconducting thick films of YBa<sub>2</sub>Cu<sub>3</sub>O(x) on MgO substrates have been used to fabricate an active antenna with a corner reflector. Useful detection of EM waves at 9.55 GHz is obtained with this antenna, which combines antenna and material properties. Fixed-polarization microwaves are radiated to the superconducting active antennas, and the detectivities and directivities are experimentally confirmed. The use of the corner reflector significantly enhances detection sensitivity and directivity.

**A92-40294 Low-profile helical array antenna fed from a radial waveguide.** HISAMATSU NAKANO, HARUO TAKEDA, YORIHIRO KITAMURA, HIROAKI MIMAKI, and JUNJI YAMAUCHI (Hosei University, Koganei, Japan). *IEEE Transactions on Antennas and Propagation* (ISSN 0018-926X), Vol. 40, No. 3, March 1992, pp. 279-284. 10 Refs.

A low-profile array antenna composed of 2-turn 4 deg pitch angle helices is designed for a frequency band of 11.7 GHz to 12.0 GHz. The feed wire of each helix is inserted into a radial waveguide through a small hole and excited by a traveling wave flowing in the transverse electromagnetic mode between the two parallel plates of the waveguide. The measured aperture efficiency shows a maximum value of 77 percent for a beam radiated in the normal direction and 69 percent for a 30 deg beam tilt. (Author)

**A92-40247 Recent activities in antennas and propagation in Japan.** KENICHI KAGOSHIM, (NTT, Radio Communication Systems Laboratories, Yokosuka, Japan); and TAKAYASU SHIOKAWA (Kokusai Denshin Denwa Co., Ltd., Kamifukuoka, Japan). *IEEE Antennas and Propagation Magazine* (ISSN 1045-9243), Vol. 34, No. 2, April 1992, pp. 18-26. 24 Refs.

Recent Japanese activities in the fields of antennas and propagation are discussed. In the realm of antennas, developments in the areas of mobile communications antennas, multibeam earth station antennas, satellite-borne antennas for ETS-VI, and the shaped-beam antenna for the Superbird commercial domestic communications satellites are examined. In addition, antennas for the Japanese Earth Resources Satellite-1 SAR, the Japanese operational DBS, and for microwave radio-relay system are briefly discussed. In the field of propagation, developments in land-mobile radio systems, mobile satellite systems, fixed-satellite communication systems, and terrestrial radio systems are examined.

**A92-40188 High gain airborne antenna for satellite communications.** SHINICHI TAIRA, MASATO TANAKA, and SHINGO OHMORI. *Communications Research Laboratory, Journal* (ISSN 0914-9260), Vol. 38, No. 2, July 1992, pp. 205-216. 10 Refs.

The performance of the world's first airborne phased array antenna is described. The antenna is compact, lightweight, has a wide frequency bandwidth, and a low axial ratio in wide scanned angles, which is realized by a sequential array technique. The antenna was tested on board a commercial jet airliner using the ETS-V satellite and was shown to meet both the electrical and the mechanical standards required for aeronautical satellite communications.

**A92-37456 Simple antenna for circular polarisation.** K. MAAMRIA, (Tohoku University, Sendai, Japan); and T. NAKAMURA, (Gifu University, Japan). *IEE Proceedings, Part H—Microwaves, Antennas and Propagation* (ISSN 0950-107X), Vol. 139, No. 2, April 1992, pp. 157, 158. 5 Refs.

The paper presents the design of a simple antenna for circular polarization. The antenna is a single-fed flat structure consisting of a pair of crossed dipoles connected through two angular branches, producing circular polarization in the axial direction. A design of the antenna with a director added to the structure to further narrow its beamwidth is analyzed. The design was realized, and its characteristics were measured at 2 GHz. It was found that measurements of the axial ratio, field pattern, and input admittance agreed well with computed values.