

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

**A92-37456 Simple antenna for circular polarisation.** K. MAAMRIA and T. NAKAMURA, *Proceedings of the IEE Antennas and Propagation, Part H—Microwaves* (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.

**A92-33625 Single shaped reflector antennas for broadcasting satellites.** KAZUYOSHI SHOGEN, HAYATO NISHIDA, and NOBORU TOYAMA, *IEEE Transactions on Antennas and Propagation* (ISSN 0018-926X), Vol. 40, Feb. 1992, pp. 178–187. 10 Refs.

For future direct broadcasting satellites (DBSs) in Japan, precisely contoured beam antennas will be required for onboard antennas. Single shaped-reflector antennas are suitable for that purpose, since they do not need complex feed networks. However, in a previous study, discontinuities in the reflector surface were observed. The problem of the discontinuity was circumvented in this work and the shaped reflectors were successfully designed to produce contoured beams for covering the Japanese islands for the downlink and feederlink antennas. The downlink antenna was fabricated, and the radiation pattern was verified by measurement. The radiation pattern meets the radio regulations imposed on the onboard antenna, such as sidelobe and cross-polarization characteristics.

**A92-31633 Broadband millimeter-wave detector using dielectric image line.** KAZUO KIKUCHI, *Microwave and Optical Technology Letters* (ISSN 0895-2477), Vol. 5, May 1992, pp. 239, 240. 7 Refs.

The broadband millimeter-wave detector using a dielectric image line is presented. The detector mount is fabricated by a hot carrier diode and a triangular unipole antenna with tapered angle of 16 degree, 39-degree flare angle and 3.4 mm length. A broadband millimeter-wave 32-50-GHz detector is obtained.

**A92-26686 A new-type antenna for continuous gravitational radiation.** T. SUZUKI, N. AKASAKA, Y. OGAWA, N. KUDO, and K. MORIMOTO, *Review of Scientific Instruments* (ISSN 0034-6748), Vol. 63, March 1992, pp. 1880–1883. 12 Refs.

A new-type disk antenna has been developed to search for continuous gravitational waves emitted from millisecond and submillisecond pulsars. The antenna not only has a wide tunable range of the eigenfrequency that covers down to almost half of the original frequency of the quadrupole mode, but also is easily tuned to an objective frequency with an accuracy of  $4 \times 10^{-5}$  at 4.2 K. The mechanical quality factor has reached  $3.0 \times 10^7$  at 4.2 K in an antenna made of A15056.

**A92-19134 A two-layer self-diplexing antenna using a circularly polarized ring patch antenna.** WATARU CHUJO, MASAYUKI FUJISE, MASAYUKI NAKANO, HIROYUKI ARAI, and NAOHISA GOTO, *IEICE Transactions* (ISSN 0917-1673), Vol. E74, Oct. 1991, pp. 3261–3267.

This paper presents a newly developed two-layer self-diplexing antenna for mobile satellite communications with mutual coupling suppression between transmitting and receiving antenna. The self-diplexing antenna is composed of circular microstrip and ring patches. Numerical results based on an electromotive force method using boundary admittance are compared with experimental results. The numerical results significantly agree with the experimental results. The experiments show that the total isolation between transmitting and receiving antennas is more than 35 dB.

**A92-19130 Vehicle antennas for mobile satellite communications.** SHINGO OHMORI, *IEICE Transactions* (ISSN 0917-1673), Vol. E74, Oct. 1991, pp. 3210–3221. 46 Refs.

Research on and the state of the art of vehicle antennas for mobile satellite communications are reviewed. Particular attention is given to the concept of mobile satellite communication; system requirements for vehicle antennas; antenna systems for communications, navigation, and broadcasting; and future prospects of vehicle antennas. A monolithic microwave integrated circuit active phased array antenna is considered to be a key technology in the future mobile satellite communications.

**A90-47884 Dual-beam antenna for DYANET.** TOSHIKAZU HORI and HISANOBU AKAGI, *NTT Review* (ISSN 0915-2334), Vol. 2, May 1990, pp. 35–40. 8 Refs.

This paper proposes a 4-reflector type double torus antenna for simultaneous dual-satellite accessing earth stations, and describes the reflector system design and characteristics of the DYANET earth station antenna. The dual-beam earth station antenna has been developed by using newly developed reflector system design techniques and mechanical studies. Measured data confirms that the 4-reflector type double torus antenna can be used for the DYANET earth station.

**A92-18517 Overview of satellite on-board multibeam communications system for ETS-VI.** SHUICHI SAMEJIMA, MASAYOSHI TANAKA, and ISAO OHTOMO, *IAF 42nd International Astronautical Congress*, Montreal, Canada, Oct. 5-11, 1991. 9 pp. 3 Refs. (IAF Paper 91-507).

A multibeam system is one of the most promising next-generation satellite communication systems. NTT is taking part in the Japanese national ETS-VI program in developing on-board equipment for fixed and mobile multibeam satellite communication systems and is preparing for the evaluation and verification of newly developed technologies. Ground verification tests of this equipment have successfully been completed and the assembly of the Proto-Flight-Model has started with the launch scheduled for 1993.

**A92-17877 Thermal design evaluation of on-board large deployable antenna.** HIROAKI TSUNODA, KATSUHIKO NAKAJIMA, and AKIHIRO MIYASAKA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 39, No. 453, 1991, pp. 504–512. 12 Refs.

A future multibeam communication satellite requires a large deployable antenna which has a total length of about 9 m, including two large main reflectors and a tower. Thermal balance test for such a large-sized antenna system are limited by the volume of a space simulation chamber. The deployment mechanisms cannot support the reflectors without damage under gravitational conditions. In order to overcome these problems, a two-step thermal design verification method is devised. First, the antenna component thermal analytical model was verified by each component test in critical test cases. Next, the antenna system thermal analytical model was verified by a system test. The antenna system test is performed by using supporting structures which support the hardpoints of each main-reflector in order to minimize the gravity force to the antenna deployment mechanisms.

**A92-16288 Analysis of a cavity-backed annular slot antenna with one point shorted.** HISASHI MORISHITA, KAZUHIRO HIRASAWA, and KYOHEI FUJIMOTO, *IEEE Transactions on Antennas and Propagation* (ISSN 0018-926X), Vol. 39, Oct. 1991, pp. 1472–1478. 12 Refs.

Analysis of a cavity-backed annular slot antenna with one point shorted is performed experimentally and theoretically. Resonance frequencies, bandwidths, and radiation patterns are studied with respect to slot width, cavity depth, and slot shorting position. In the theoretical analysis, the method of moments is applied to find the magnet current on the slot, and the Green's function for the field inside the cavity has been newly derived. By selecting a slot shorting position, circular polarization, and a bandwidth of more than 10 percent, the voltage standing-wave ratio (VSWR) not greater than 2 for the input impedance is obtained.

**A92-14732 Structural design of a 10 M diameter tension truss antenna.** KORYO MIURA, TADASHI TAKANO, TOSHIO INOUE, and KAZUO TANIZAWA, *IAF 42nd International Astronautical Congress*, Montreal, Canada, Oct. 5-11, 1991. 11 pp. 6 Refs. (IAF Paper 91-316).

A 10m diameter tension truss antenna for the ISAS's engineering test satellite Muses-B will be launched in 1995. This antenna will be used for the VLBI Space Observatory Program (VSOP). The required surface accuracy of the antenna is 0.5 mm rms. Muses-B will be launched by M-5, and the envelope's diameter is less than 2200 mm. Since the effectiveness of the present design depends heavily on the cable materials and stiffness, the study was performed to find the best choice of cable materials with consideration for such factors as thermal deformation, slackening, and available extendible mast stiffness. It is shown that the mesh surface approximation error is less than 0.3 mm rms, that the effect of stiffness change by the radio active ray on the surface accuracy is negligible, and that the effect of moisture loss is large but can be canceled by the initial offset.

**A92-14731 A modular approach to build a large space antenna.** JIN MITSUGI, and TETSUO YASAKA, *IAF 42nd International Astronautical Congress*, Montreal, Canada, Oct. 5-11, 1991. 11 pp. 4 Refs. (IAF Paper 91-315).

Large deployable mesh antenna composed of independently manufactured and tested modules is presented and its feasibility for a 10-m aperture, C-band application is examined from the surface accuracy point of view. The required accuracy of a module under possible imperfection between modules is derived. The tensions in the mesh surface to achieve the module accuracy is elicited by modeling the mesh with an equivalent cable network. Results give a mesh surface that could be considered as flat among the shaping cable network.

**A91-44748 Backfire/endfire radiation performance of quadrifilar helical antennas.** N. TERADA and K. KAGOSHIMA, *Electronics Letters* (ISSN 0013-5194), Vol. 27, June 6, 1991, pp. 1108, 1109.

The relations between radiation pattern and feeding method in quadrifilar helical antennas is discussed. As a result, it is found that by changing the phase of each wire the helical antenna can achieve two radiation modes; both backfire and endfire radiation. These patterns do not have a difference except in radiation direction. Antenna polarization of quadrifilar helical antenna depends only on the helical winding direction.

**A91-52825 Design and characteristics of the high-accuracy on-board antenna pointing control system.** YOICHI KAWAKAMI, HIROSHI HOJO, MASAZUMI UEBA, and HIROSHI TANAKA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 39, No. 450, 1991, pp. 373-378. 6 Refs.

For the ETS-VI antenna system applied to multibeam satellite communication experiments, a new on-board antenna pointing control system and its components were developed to achieve the antenna pointing accuracy requirement. The antenna pointing control system consists of both a conventional satellite attitude control system and an antenna drive control system. The antenna drive control system tracks a beacon transmitted from an earth station independently of satellite attitude control by driving a subreflector. Control accuracies of the system were confirmed to be within 0.002 degrees through control simulations using on-board hardwares with two three-axis motion tables and an RF sensor simulator. The ETS-VI antenna pointing accuracy is estimated to be within 0.015 degrees.

**A91-50370 Loaded bifilar helical antenna with small radius and large pitch angle.** H. NAKANO, H. MIMAKI, and J. YAMAUCHI, *Electronics Letters* (ISSN 0013-5194), Vol. 27, Aug. 15, 1991, pp. 1568, 1569. 5 Refs.

A bilar helical antenna (BHA) with a small radius (0.04 wavelengths) and large pitch angle (68 deg) is analyzed using numerical techniques. To reduce the antenna length, the BHA is terminated with a resistive load. A six turn BHA with a resistive load of 400 Ohms can generate a split beam of circular polarization, whose direction moves to the horizontal plane (X-Y plane), as the frequency is increased. The frequency response for the gain shows that the BHA has a medium gain ranging from 7 to 10 dB.

**A91-37151 A side-looking SAR with a DBF antenna.** TAKAHIKO FUJISAKA, YOSHIMASA OH-HASHI, and MICHIMASA KONDO, *Proceedings of the 2nd International Symposium, Noise and clutter rejection in radars and imaging sensors*, Kyoto, Japan, Nov. 14-16, 1989 (A91-37076 15-32). Amsterdam, Elsevier Science Publishers, 1990, pp. 738-743. 5 Refs.

A side-looking SAR (synthetic aperture radar) with a DBF (digital beamforming) antenna was found to improve its cross-range resolution in proportion to the number of antenna beams without increasing PRF (pulse repetition frequency). The cross-range compression algorithm of the SAR is discussed, and it is shown that the algorithm gives good results by computer simulations.

**A91-37113 Effect of observational and environmental conditions on antenna temperature.** YASUNORI SASAKI, ICHIO ASANUMA, KEI MUNEYAMA, GEN'ICHI NAITO, and TSUTOMU SUZUKI, *Proceedings of the 2nd International Symposium, Noise and clutter rejection in radars and imaging sensors*, Kyoto, Japan, Nov. 14-16, 1989 (A91-37076 15-32). Amsterdam, Elsevier Science Publishers, 1990, pp. 335-340. 5 Refs.

The effects of some observational and environmental parameters on the observed antenna temperature are evaluated and the magnitude of error due to each effect is discussed. Typical parameters in the observational condition are antenna pattern, platform attitude, polarization type, incidence angle, frequency, and beam efficiency. Parameters in the environmental condition include earth surface curvature and ambient temperature. Simulations are performed using surface and satellite sensors. Results show that the antenna temperature was greatly dependent on both the environmental and the observational conditions.

**A91-32340 An analysis of a waveguide T junction with an inductive post.** JIRO HIROKAWA, KIMIO SAKURAI, MAKOTO ANDO, and NAOHISA GOTO, *IEEE Transactions on Microwave Theory and Techniques* (ISSN 0018-9480), Vol. 39, March 1991, pp. 563-566. 6 Refs.

The authors analyze the T junction with an inductive post, taking its diameter into account for the case where the current distribution is assumed on the surface of the post. A single cylindrical post placed in a T junction improves the impedance matching and compensates the junction discontinuity in a wide frequency band. The effects of the design parameters, such as the diameter of the post and its location, are clarified. The measured return loss is accurately predicted. On the basis of this analysis, an effective design procedure for the T junction is proposed, and the reflection below -30 dB is realized over 4 percent bandwidth.

**A91-26629 Active stabilization of a large flexible antenna feed support structure.** M. S. ELBUNI and M. HIGASHIGUCHI, *IFAC Symposium, Automatic control in aerospace*, Tsukuba, Japan, July 17-21, 1989, Selected Papers (A91-26606 10-12). Oxford, England and New York, Pergamon Press, 1990, pp. 171-176.

The paper extends a design procedure that uses pole placement in a vertical strip and degenerate control. The control logic was synthesized using collocated actuators and sensors to obtain an output feedback gain matrix which results in a stable closed-loop system with desired performance qualities. Active stabilization to hold a feed at the focus of a large antenna dish is considered. Using the symmetry of the structure the model is decomposed into two subsystems and the algorithm is applied to both the coupled and decoupled systems. The controller performance given as a time history of a line of sight error is investigated for both systems. The effect of gradually shifting the vertical strip in the s-plane is investigated. In addition, the relation between the amount of damping introduced and the location of the vertical strip is studied.

**A91-25646 Dual-spiral slot antennas.** K. HIROSE and H. NAKANO, *Proceedings of the IEE Antennas and Propagation, Part H—Microwaves* (ISSN 0950-107X), Vol. 138, No. 1, Feb. 1991, pp. 32-36. 13 Refs.

Two types of dual-spiral slot antennas characterized by their simple feed are studied: one is a bidirectional radiation type (Bi-DSS) and the other is a unidirectional type (Uni-DSS). The radiation characteristics of the Bi-DSS are evaluated using the numerically determined magnetic current distribution. It is found that a traveling wave magnetic current distribution becomes dominant for a particular range of slot-arm lengths, contributing to the radiation of a circularly polarized wave. On the basis of the investigation of the Bi-DSS radiation mechanism, the Uni-DSS antenna with a triplate configuration is designed. Formation of a circularly polarized, unidirectional beam is experimentally realized. A 4 x 8 Uni-DSS array antenna with a simple feeding system is constructed, achieving an aperture efficiency of 60 percent over a frequency range of 11.6 GHz to 12.0 GHz.

**A91-20451 Three-antenna poststatistic steering using the MU radar.** ROBERT D. PALMER, RONALD F. WOODMAN, SHOICHIRO FUKAO, TOSHITAKA TSUDA, and SUSUMU KATO, *Radio Science* (ISSN 0048-6604), Vol. 25, Nov.-Dec. 1990, pp. 1105-1110. 11 Refs.

This paper derives useful expressions for the synthesized beam statistics using poststatistic steering (PSS), when three antennas are used in a spatial interferometer configuration for two-dimensional steering. These antennas may have arbitrary position and can have nonorthogonal baselines. The use of three (noncollinear) antennas allows altitude dependent two-dimensional steering. This technique is verified using spatial interferometer data obtained in October 1989 using the MU radar, including PSS in directions parallel and perpendicular to the wind direction, which is a very convenient advantage of the technique.

**A91-20367 Ku band electric models for large deployable mesh reflector antenna.** S. SATO, A. ISO, T. ORIKASA, and T. SUGIMOTO, *Electronics Letters* (ISSN 0013-5194), Vol. 26, Dec. 6, 1990, pp. 2091-2093. 6 Refs.

Two scaled electric models of mesh reflectors have been constructed to evaluate the electrical performance of a 30 m aperture diameter large deployable antenna. Radiation characteristics have been measured, particularly the cross-polarization level in the case of circular polarization. The similarities between the measured and calculated results are very close. The cross-polarization level is low, and it is very likely that frequency reuse using dual polarization is possible.

**A90-43432 Development of a very small receive-only earth station for the 20 GHz frequency band.** MASA-AKI IGUCHI, SYUNKICHI ISOBE, MAKOTO TAKEUCHI, ICHIRO YAMAZAKI, SHIGETOSHI YOSHIMOTO et al., *Communications Research Laboratory Review* (ISSN 0914-9279), Vol. 36, March 1990, pp. 19-29. 8 Refs.

In order to give new satellite communication services assured status, a very small receive-only earth station operating in the 20-GHz frequency band has been developed. This earth station consists of a receive antenna with a diameter of 30 cm, an HEMT low-noise receiver, and a CPFSK demodulator operating at 9.6 kbps. The antenna and the receiver are designed as a single unit, which can be used on a desk top and is easy to operate. The system noise temperature of the HEMT receiver is about 190 K at room temperature. The G/T of the station is 10.8 dB/K.

**A90-35997 Equatorial radar system.** SHOICHIRO FUKAO, TOSHITAKA TSUDA, TORU SATO, SUSUMU KATO et al., 27th Plenary Meeting, Workshops and Symposium on the Earth's Middle Atmosphere, Espoo, Finland, July 18-29, 1988. *Advances in Space Research* (ISSN 0273-1177), Vol. 10, No. 10, 1990, pp. 151-154.

A large clear air radar with the sensitivity of an incoherent scatter radar for observing the whole equatorial atmosphere up to 1000 km altitude is now being designed in Japan. The radar will be built in Pontianak, West Kalimantan, Indonesia (0.03 deg N, 109.29 deg E). The system is a 47-MHz monostatic Doppler radar with an active phased array configuration similar to that of the MU radar in Japan, which has been in successful operation since 1983. It will have a PA product of about  $3 \times 10$  to the 9th W sq m ( $P$  = average transmitter power,  $A$  = effective antenna aperture) with a sensitivity of approximately 10 times that of the MU radar. This system configuration enables pulse-to-pulse beam steering within 20 deg from the zenith. As is the case of the MU radar, a variety of operations will be made feasible under the supervision of the radar controller. A brief description of the system configuration is presented.

**A91-25034 Analysis of coaxial collinear antenna—Recurrence formula of voltages and admittances at connections.** AKIHIDE SAKITANI and SHIGERU EGASHIRA, *IEEE Transactions on Antennas and Propagation* (ISSN 0018-926X), Vol. 39, Jan. 1991, pp. 15-20. 9 Refs.

A method for the analysis of the coaxial collinear antenna made of transposed coaxial sections of arbitrary length is presented. The excitation terms of the integral equation for the current distribution of this antenna are expressed by using a known impressed voltage, and these are computed recursively by computer. Calculated values of current distributions and input impedances are found to agree with measured results, and the validity of the presented method is confirmed. The results derived are applicable to the design of the coaxial collinear antennas of any configuration.