OPTIMIZATION OF A LINEARLY POLARIZED RADIAL LINE SLOT ARRAY ANTENNA DESIGN FOR DIRECT BROADCAST SATELLITE SERVICES

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DEDICATION

Dedicated to late Pastor Iliya Zakwoi; my father; who inspired me educationally and to Mrs Kande Zakwoi my mother; whose presence reminds me of my growing days and the struggles to attain the peak educationally. To my family ,brothers, sisters and friends

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ABSTRACT

Azimuthal components of beam squint design techniques for Linearly Polarized Radial Line Slot Array (LP-RLSA) antena was in the past chosen arbitrarily, which accounted for waste of quality design/simulation time and by extension the entire fabrication processes when poor design parameter is selected arbitrarily. This thesis introduces a more scientific method of identification and selection of azimuthal components (S_ϕ) as a function of phi (ϕ), thetaT (θ_T) and phiT (ϕ_T) respectively via a numerical technique, which identifies optimal design parameters and formulates optimal equations. The thesis further studies the behaviour of dielectrics as it relates to the performance of the LP-RLSA antenas and has put in place suitable dielectric permittivity values required at Ku Band (12.25 - 12.75) GHz. Thus, a directivity value of more than 33.00 dBi was achieved at a frequency of 12.4 GHz with a reflection coeficient value less than -23.26 dB and a bandwidth of about 41% of 500MHz required. A radiation efficiency value of about 67% was achieved. Relationships between half power beam width (HPBW), slot widths (w) and antenna directivity (D) were studied, a new directivity relationship resulting from the study was formulated for the Ku Band (12.25 - 12.75) GHz. Research on the Ka Band LP-RLSA antenna design as an emerging technology for future satellite DBS service application at (21.4 - 22.0) GHz was done; CST MWS simulations were used, about 4 dBi higher in value of simulated directivity was obtained compared to the Ku Band design (12.25 - 12.75) GHz of same dish size (600 mm), with a bandwidth of about 41% of the 600 MHz required for the Ka Band DBS application at 21.699 GHz and 36.2 dBi realized. Good return loss performance of the Ka and Ku Bands design was achieved. Measured results for the Ku Band are in excellent agreement with the simulation results.

ABSTRAK

Komponen azimut pada teknik pemesongan arah untuk Antena Tatasusunan Berkutub Lelurus (LP-RLSA) telah dipilih secara rawak, telah dikenal pasti sebagai suatu pembaziran kualiti reka bentuk/masa simulasi dan sambungan keseluruhan proses fabrikasi apabila parameter reka bentuk yang lemah dipilih. Tesis ini telah memperkenalkan kaedah saintifik dalam mengenal pasti dan memilih komponen azimuth (S_ϕ) sebagai fungsi kepada phi (ϕ), theta T (θ_T) dan phi T (ϕ_T) melalui teknik numerikal yang mengenal pasti parameter reka bentuk yang optimum dan formulasi persamaan optimum. Tesis ini mengkaji ciri-ciri dielektrik dan hubungannya ke atas prestasi antenna LP-RLSA dan disesuaikan dengan nilai permitiviti bahan dielektrik yang diperlukan pada Jalur Ku (12.25 - 12.75) GHz. Maka, nilai kearahan lebih daripada 33.00 dBi telah dicapai pada frekuensi 12.4 GHz dengan nilai kehilangan balikan kurang daripada -23.26 dB dan lebar jalur 41% pada 500 MHz yang diperlukan. 67% nilai kecekapan radiasi telah dicapai. Hubungan antara kuasa separa lebar alur (HPBW), lebar slot (w) dan kearahan antena (D) dikaji, hubungan baru kearahan diperolehi dan diformulasi untuk Jalur Ku (12.25 - 12.75) GHz. Penyelidikan LP-RLSA pada Jalur Ka menjadikan ia suatu teknologi masa hadapan untuk aplikasi penerimaan isyarat penyiaran satelit pada (21.4 - 22.0) GHz telah dilakukan; dengan menggunakan perisian simulasi CST 2013 telah mencapai 4 dBi lebih tinggi nilai kearahannya berbanding reka bentuk pada Jalur Ku (12.25 - 12.75) GHz untuk diameter yang sama (600 mm), dengan jalur lebar 4% pada 600 MHz yang diperlukan untuk Jalur Ka aplikasi DBS pada 21.699 GHz dan 36.2 dBi telah diperolehi. Prestasi kehilangan balikan yang baik telah diperolehi pada Jalur Ka dan Jalur Ku. Keputusan pengukuran pada Jalur Ku adalah menyamai keputusan pada simulasi.