ISSN: 2349-6495

Circularly Polarized Dualband Switched-Beam Antenna Array for GNSS

A. Renuka devi[1], S. Senthilkumar[2] , L. Ramachandran[3]

[1]PG Scholar, Department of Electronics and Communication Engineering,
E.G.S Pillay Engineering College, Nagapattinam, Tamil Nadu

[2,3]Assistant Professor. Department of Electronics and Communication Engineering,
E.G.S Pillay Engineering College, Nagapattinam, Tamil Nadu

Abstract— *Circularly polarized antenna arrays are useful in numerous applications such as GNSS remote sensing, surveillance, interference mitigation, and satellite communications particularly at L and S bands. Circularly polarized antenna arrays are also a major candidate for GNSS anti-jamming and interference mitigation applications. A variety of techniques such as null steering, beam switching, adaptive polarization etc. GNSS remote sensing applications like ocean reflectometry use the L-band navigation signals already being transmitted by global positioning system (GPS), global navigation satellite system (GLONASS), and Galileo systems for estimating the wind speed and direction of ocean currents. The high-gain antenna array onboard the satellite picks up GNSS signals reflected by the ocean surface and processes them for the corresponding measurements. The antenna beam is usually directed away from the Nadir direction in order to increase the visibility of the reflected signals. Moreover, availability of the L2 GNSS signal for civilian use (L2C) has allowed data collection at more than one frequency which helps to improve accuracy and determine the ionosphere effects through differential measurements.*

Keywords— GNSS , buttler matrix. Circular polarization

I. INTRODUCTION

GNSS:

This GNSS system presents the design of a circularly polarized dual band switched-beam antenna array for GNSS reflectometry applications. The antenna design is a four-element linear array incorporating a broadband switching mechanism in order to provide
continuous coverage for $\pm 25°$ around the bore sight.

Figure 1 GNNS Applications

Since GNSS signals change their polarization to left-hand circular after reflecting from the surface of the ocean, the proposed antenna array is designed to receive left-hand circular polarized (LHCP) signals. Antenna simulation results show that the array achieves a maximum bore sight gain of 12 dB at the L1 band while 10 dB at the L2 band. The proposed switched-beam network is then integrated with dual-band step-shorted annular ring (S-SAR) antenna elements in order to produce a fully integrated compact-sized switched-beam array. In order to validate the concept, a scaled down prototype of the simulated design is fabricated and measured. The proposed antenna and the integrated beam switching network use low-cost PIN diodes in order to switch between four different beam directions. The beam switching and multiple frequency allows for higher resolution in remote sensing applications.

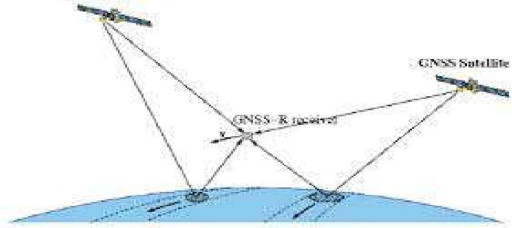

Figure 2 GNNS Transmission

SATTELITE:

Satellites are widely used these days for everything from navigation, in the case of GPS, Satellites are widel Satellites are widely used these days for

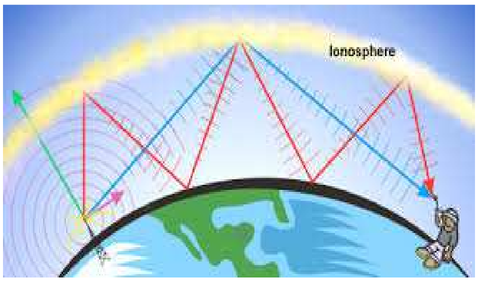

Figure 3: ionosphere transmission

everything from navigation, in the case of GPS, satellite television broadcasting, communications, mobile phone technology, Internet broadband weather monitoring and much more.

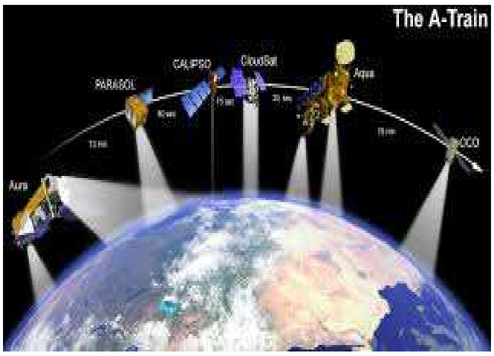

Figure 4: GNNS global link

Satellites normally use frequencies that are in excess of 500 MHz where the signals are not unduly affected by the ionosphere or troposphere. However some effects can be noticed and are important, especially when planning, installing or setting up a satellite system.

When signals travel from the ground up to the satellite they pass through four main regions. These are the troposphere, above which is region that is often termed inner free space which is above the troposphere and below the ionosphere. The next region is the ionosphere, and finally there is the outer free space.

BUTTLER MATRIX:

Butler matrices are used to design multi-port amplifier and especially to design smart antennas with switched radiation beams for communications systems. Some of them are dual-band systems. Circuits working at both bands are useful to increase the integration level. At microwave frequencies is difficult to design a circuit with the same behavior at two uncorrelated frequencies, so the above commented systems often share only a dual-band antenna and the frequency bands are separated using diplexer

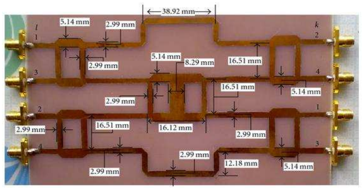

Figure 5 feeding network in hardware

II. SWITCHED BEAM ANTENNA ARRAY

The proposed technique use Micro controllers to provide an open or short circuit at the point of contact. These micro controllers can provide minimum insertion loss while keeping the overall antenna size small and low cost. This system presents the simulation layout of a small feed network demonstrating the isolation of micro controller as a switch. The design of a low-cost dual-band switched-beam circularly polarized array antenna for GNSS reflectometry applications has been presented. The proposed antenna and the integrated beam switching network use low-cost micro controllers in order to switch between four different beam directions.

GNSS signals change their polarization to left-hand circular after reflecting from the surface of the ocean, the proposed antenna array is designed to receive left-hand circular polarized (LHCP) signals. The proposed beam switching network uses small micro strip lines with micro controllers to achieve the appropriate phase difference between antenna elements and to achieve better isolation between the switching legs. The prototype operates at twice of the original design frequency, i.e., 3.15 GHz and 2.454 GHz and the measured results confirm that the integrated array achieves beam switching and good performance at both bands.

DESIGN:

A corporate type 1 to 4 power splitter is used as the basic design for the feed network. A single 50 input transmission line is split into two 100 lines to achieve equal power split. Each 100 section is transformed back to 50 transmission line by using an impedance matching quarter wavelength transformer (marked by red boxes). The same sequence is applied again in order to achieve further power split. Branches are then connected to a broadband compact branch line coupler (marked by black boxes) in order to achieve circular polarization at multiple frequencies. It is worth mentioning that two of the four hybrid branch line couplers are physically inverted and thus 180 phase compensation should be provided in order to achieve maximum gain in the required direction. This is achieved by adjusting the line length of the top (feed) part.

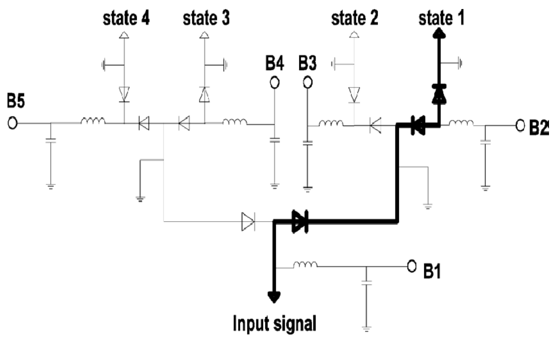

Figure 5 feeding network

III. FLOW GRAPH FOR ANTENNA DESIGN

DESIGN OF A SWITCHING NETWORK:

To employ a switching mechanism ensuring an appropriate phase difference between consecutive branches for multiple switching states.

Two such switches, one at the top and the other at the bottom of the feed network vary the phase difference between the four antenna elements.

DESIGN OF S-SAR ANTENNA:

A shorted annular ring antenna element is used as it is well known for its capability to minimize the surface and lateral wave propagation.

The two most important dimensions of the annular ring antenna are the internal and external radii of the annular ring.

The inner boundary, need to be shorted to the ground and its value determines the resonant frequency.

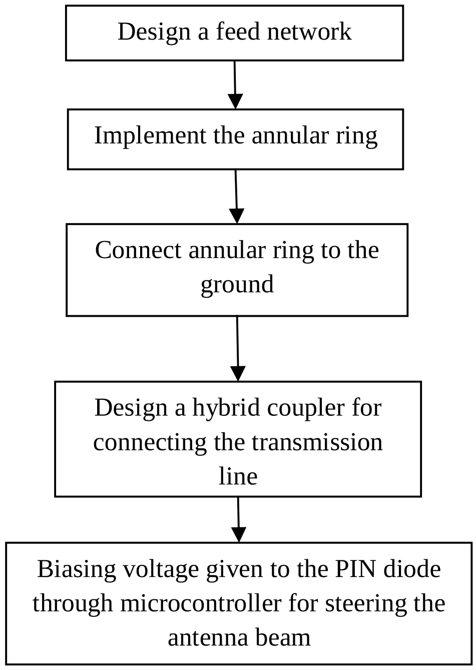

Figure 6 Flow graph

DESIGN OF ANTENNA ARRAY

The dc biasing circuit is removed to give more clarity while the Micro controller locations are represented by small gaps.

The required beam switching directions are calculated in order to provide a continuous coverage across bore sight.

The corresponding values of relative phase difference are evaluated with respect to the center frequency of 1.4 GHz.

IV. MANUFACTURING AND MEASURING

To validate the beam switching capability of the proposed broadband feed network, a scaled down prototype of the antenna array was fabricated.

External wires were connected to the integrated antenna to provide 5-V dc biasing voltage and micro controller too.

Antenna measurements were carried out in a local anechoic chamber. The chamber was calibrated from 2 GHz to 4 GHz.

The accumulated 3-dB beam width of the array antenna across the bore sight.

V. CONCLUSION

The design of a low-cost dual-band switched-beam circularly polarized array antenna for GNSS reflectometry applications has been presented. The proposed antenna and the integrated beam switching network use low-cost PIN diodes order to switch between four different beam directions. The beam switching and multiple frequency allows for higher resolution in remote sensing applications. In comparison to a previously reported SPMT switching technique, the use of PIN diodes enhances the operational bandwidth and also improves the isolation between switching legs. The high-gain antenna array onboard the satellite picks up GNSS signals reflected by the ocean surface and processes them for the corresponding measurements. The antenna beam is usually directed away from the Nadir direction in order to increase the visibility of the reflected signals. Moreover, availability of the L2 GNSS signal for civilian use (L2C) has allowed data collection at more than one frequency which helps to improve accuracy and determine the ionosphere effects through differential measurements.

REFERENCES

[1]]M. Unwin, S. Gao,R. De VosVan Steenwijk, P. Jales, M. Maqsood, C. Gommenginger, J. Rose, C. Mitchell, and K. Partington, "Development of low-cost spaceborne multi-frequency GNSS receiver for navigation and GNSS remote sensing," Int. J.Space Sci. Eng., vol. 1, no. 1, pp.
20–50,

[2] M. Maqsood, B. Bhandari, S. Gao, R. D. Steenwijk, and M. Unwin, "Development of dual-band circularly polarized antennas for GNSS remote sensing onboard small satellites," presented at the ESA Workshop on Antennas for Space Applications, ESTEC, The Netherlands, 2010.

[3] P. R. Akbar, S. S. J. Tetuko, and H. Kuze, "A novel circularly polarized synthetic aperture radar (CP-SAR) system onboard a Spaceborne platform," Int. J. Remote Sens., vol. 31, no. 4, pp. 1053–1060, 2010.

[4] Y. Jiang, H. Yang, and X. Wang, "The design and simulation of an S-band circularly polarized microstrip antenna array," presented at the Symp. Progress in Electromagnetics Research, Xi'an, China, Mar. 22–26, 2010.

[5] M. M. Casabona and M.W. Rosen, "Discussion of GPS anti-jam technology.," GPS Solutions vol. 2, no. 3, pp. 18–23, 1999.

[6] P. Kumar and N. Bisht, "Stacked coupled circular microstrip patch antenna for dual band applications," presented at the Progress In Electromagnetics Research Symposium Proceedings, Suzhou, China, Sep. 12–16, 2011.

[7] J. Butler and R. Lowe, "Beam-forming matrix simplifies design of electronically scanned antennas," Electron. Des., vol. 9, pp. 170–173, Apr. 12, 1961.

[8] C.-C. Chang, R.-H. Lee, and T.-Y. Shih, "Design of a beam switching/ steering butler matrix for phased array system," IEEE Trans. Antennas Propag., vol. 58, no. 2, pp. 367–374, Feb. 2010.

[9] A. P. Thakare and R. N. Shelke, "Planar implementation of ButlerMatrix feed network for a switched multibeam antenna array," in IEEE Region 10 Conf. TENCON 2009, pp. 1–3, vol., no..

[10] T. A. Denidni and T. E. Libar, "Wide band four-port butler matrix for switched multibeam antenna arrays," in 14th IEEE Proc. Personal, Indoor and Mobile Radio Communications. PIMRC 2003. , vol. 3, pp. 2461–2464.

[11] J. Ouyang, "A circularly polarized switched-beam antenna array," IEEE Antennas Wireless Propag. Lett., , vol. 10, pp. 1325–13