DESIGN OF HIGH FREQUENCY LARGE INTELLIGENT SURFACES USING REFLECTARRAY ANTENNAS

Graduate student : Sanjay Kumar Vijaya Kumar, Electrical engineering, School of ECEE, Arizona state university
Faculty mentor : Dr. Georgios Trichopoulos, Terahertz electronics laboratory, School of ECEE, Arizona state university

Introduction

The future of mobile communication systems is promising with the development and implementation of 6th Generation (6G) and beyond wireless networks. In accordance [1] with the CISCO [Feb. 2019] report, by the year of 2022, the number of connected networks is expected to reach upto 28.5 billion among which, 12.3 billion is envisioned to be mobile-compatible networks. Ever since, there has been an increasing demand for better data rates, low-latency services [3] and efficient wireless communication systems. The on-going deployment of 5G networks [2] [4] clearly manifests the characteristic limitations of the system and since then the development of 6G wireless networks became the hottest topic in communications research. Applications of 6G wireless systems include high-speed mobile networks, smart homes and cities and next generation artificial Intelligence (AI) applications. Over the past couple of years, a lot of solutions came up as a response to the problems faced but the concept of Large Intelligent Surfaces (L.I.S) was a breakthrough technology among all of those solutions.

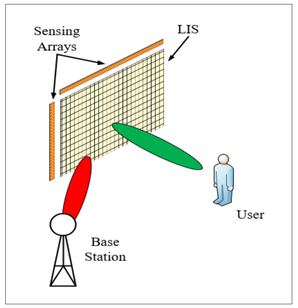

Fig.1. L.I.S with the sensing array network

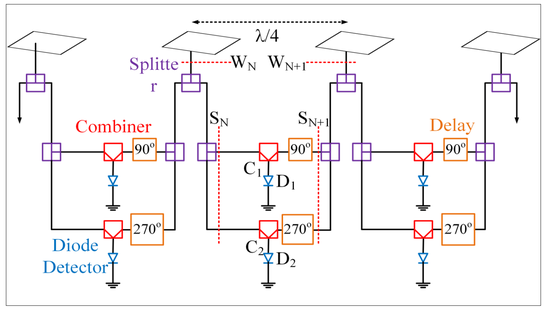

Fig.2. Proposed dual-diode receiver architecture

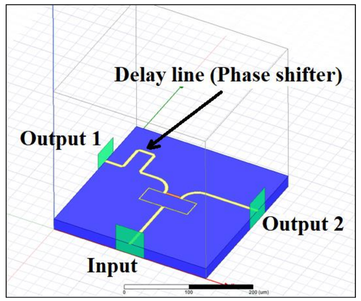

Fig.3. Wilkinson power divider with delay-line

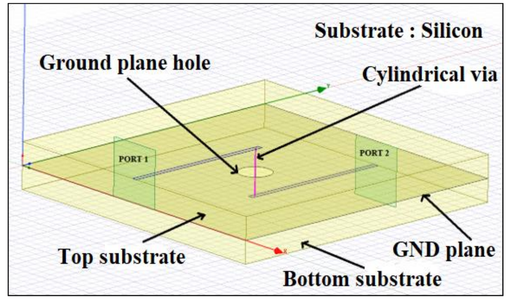

Fig.4. Interconnect Via

Objectives

- To design a microwave passive network that can perform signal splitting and phase shifting operation between the incoming signals to estimate the relative phase difference between successive patch antennas in Ansys HFSS
- To design interconnects that will integrate the passive network with direct-detection array in Ansys HFSS
- To compare and contrast the performance of this passive array network against a conventional heterodyne architecture

Methodologies

- The signal splitting operation was first carried out by designing a wilkinson power divider which is a special class of power divider than can provide high isolation between the output ports while equally splitting the input power
- Next, a delay-line phase shifter was created by re-designing the arm of wilkinson power divider to generate phase shifts of 90° and 270°
- Lossless interconnects were designed to transmit RF signal between different ports via dielectric substrates for integration purposes

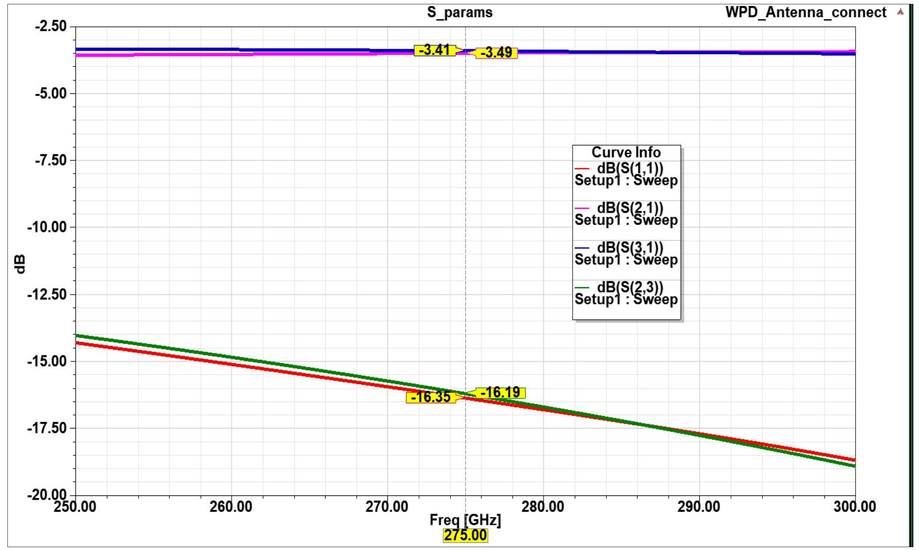

Fig.5. S-parameters of wilkinson power divider

Results

The next phase of the LIS project focused on the design of dual-diode direct detection architecture which essentially acted as a sensing network for these LIS surfaces. For example, this mechanism can detect the direction of an incoming signal from a base-station and relatively estimate the user's location based on the observed phase difference between the two signals. The array is comprised of pairwise interconnected antennas that are appropriately coupled to power receivers enabling the phase measurement between each pair. This architecture exploits solely passive components avoiding active components like mixers, local oscillators etc. and does not require any quasi-optical components, thus retaining a low-profile. This architecture was studied to be a better alternative for the heterodyne structure which is power consuming and lossy. Hence, we prove this passive microwave networks to be energy efficient for wireless applications.

References

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[2] S. Hu, F. Rusek and O. Edfors, "Beyond Massive MIMO: The Potential of Data Transmission With Large Intelligent Surfaces," in *IEEE Transactions on Signal Processing*, vol. 66, no. 10, pp. 2746-2758, 15 May15, 2018.

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