

Research Project Proposal for Masters Research 2020

Section A: Overview of the Research Project Proposal

Academic level of research project: Masters

Broad field of research: Engineering

Title of the research project: Investigate the use of ground plane slots in the design of Wideband Planar Marchand Baluns.

Abstract/Summary:

Baluns are used to provide balanced feeding of antennas such that amplitude and phase are equally distributed. Additionally, baluns can provide impedance transformation. The bandwidth over which the balun operates needs to be as wide as possible so that they do not limit the performance of wideband antennas (such as the Sinuous Antenna and other reflector feed antennas).

It has been reported, that the use of slots below the coupled lines in a Planar Marchand Balun can be used to great effect to alter the odd and even impedances thereby greatly improving the bandwidth performance. In this project, we are interested in developing clear design guidelines for slot design and to develop circuit models for better understanding of the theory of operation.

Section C: Full Research Project Proposal

1. Scientific Merit

The goal of this research project is to develop our understanding and establish clear design guidelines how to best design the planar marchand balun with slots (or floating grounds)

beneath the coupled lines. We know from other works [1-2] that there exists performance benefits by the inclusion of these structures. What is unclear is how the parameters of the slot (its size, shape and location) is best suited for a particular application.

The marchand balun is used to provide for balanced feeding of wideband antennas and as such this work has direct benefit to projects like the SKA and also general scientific merit to the community at large.

[1] Z.-Y. Zhang, Y.-X. Guo, L.-C. Ong, and M. Y. W. Chia, "A new planar Marchand balun," in *IEEE MTT-S Int. Dig.*, 2005, pp. 1971–1974.

[2] C.H. Tseng, and Y.C. Hsiao" A New Broadband Marchand Balun Using Slot-Coupled Microstrip Lines," in *IEEE Microwave and Wireless Components Letters* , Vol. 20 , no. 3, March 2010, pp. 157-159.

2. Feasibility

Methods:

This work will feature lots of simulation work, both full-wave solvers like CST Microwave Studio and Microwave Circuit Solvers like AWR. UCT is fully capable of handling this requirement.

To verify models and simulation results there is need to do rigorous testing. Thus numerous design prototypes will be built and their performance will be validated in our RF Lab which houses all the test equipment we require.

This project is expected to take 2 years.

1st year objectives – extract circuit models of both the slotted ground plane and floating ground versions of the planar marchand balun. We will begin with the basic rectangular slot.

2nd year objectives – Expand theory of understanding by exploring other slot shapes.

Develop design guidelines and complete experimental verification.

This research is linked to priority area 3: "Radio Astronomy antennas and receivers." The balun is an important device that allows for a balance current distribution on the feed antenna that will illuminate the dish. The benefits of this work is that performance of such structures/devices can be improved and also analysis methods/models can potentially be used elsewhere to benefit the project.

The ideal student should have an aptitude for problem solving and creative thinking. He/she should have an interest in Electromagnetics or Microwave Theory.

A handwritten signature in black ink, appearing to be 'D. M. H.', with a long horizontal flourish extending to the right.

18 September 2019