

## A Planar Marchand balun with patterned ground plane

### 1. Description

We present here a Marchand balun design, operating at 2.4 GHz with a 1 GHz bandwidth validated through an S-Parameter HFWorks simulation. The balun has shown good performance in equally splitting the input power and creating a 180° phase shifting between the two outputs.

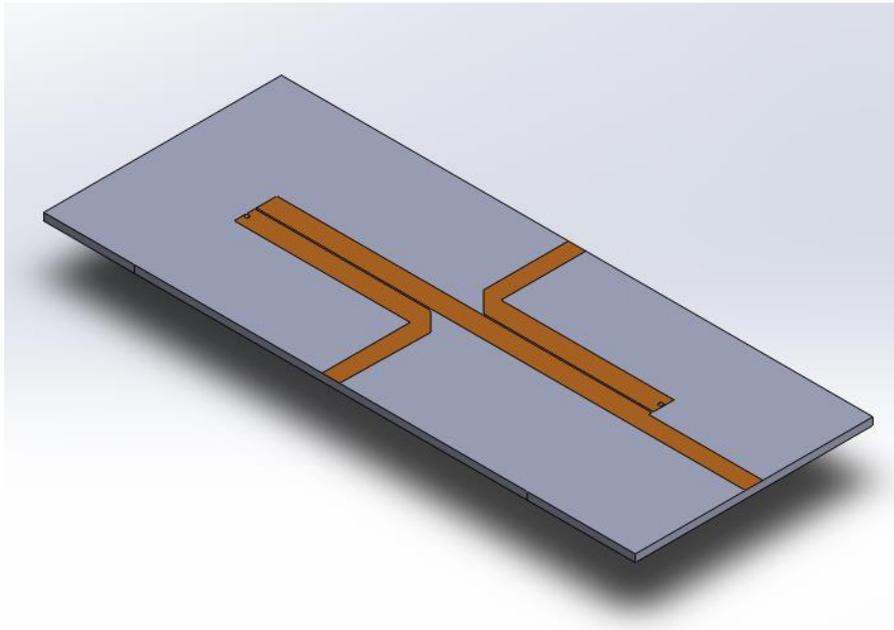


Figure 1: Marchand balun structure

### 2. Simulation

The Scattering Parameters solver is the most suitable analyzer for such a structure as it offers the aimed variables and frequency responses: Return Loss, Insertion loss, Relative phase shifting between input and output signals... etc. The mesh should be fine enough on the conductor's, ground slot's surfaces and on the via as well.

### 3. Load/ Restraint

The conductor is printed on a 0.8 mm thickness RO4003 substrate ( $\epsilon_r = 3.38$ ) and is considered as a zero thickness conductor (the split line features is used). We have at the end of each output port's branch a small via (vertical pin between the conductor path and the ground plane). An air box is modeled on top of the substrate and is preferably extended to the bottom as well in order to take into account the radiation from ground slots.

For ports assignment, we should keep in mind that the ports' impedances have several ways to be computed. Thus, your results will depend on the type of impedance you suggest. HFWorks enables you to investigate each impedance the port results without having to simulate the whole

structure. You can simply check “Skip 3D solution” in the study properties window to do so. Now we come to the part of defining the integral lines for Zpv and Zvi computation. HFWorks needs this line for the impedances as both of them require an expression of the voltage on the port. The integration line is defined by two points that lie on the port’s surface: the two points indicate a path where the Electric Field is assumed highest. On the other hand, we can use the calibration path feature to give a constraint to the orientation of the Electric Field and thus the mode of the port.

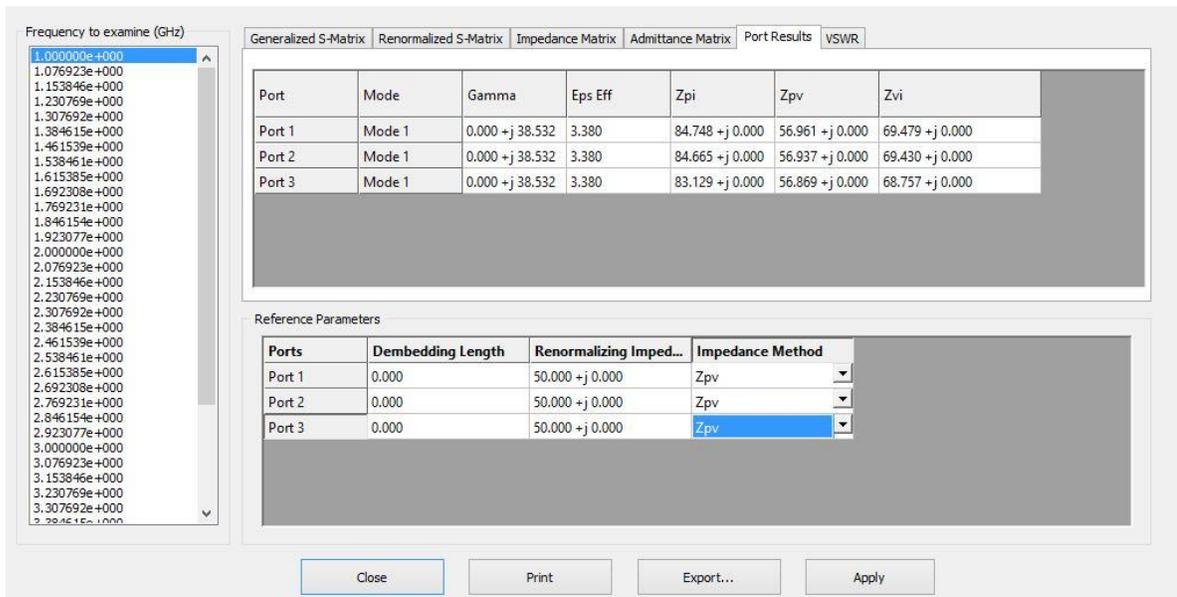


Figure 2: Impedances of the port

#### 4. Result

To validate the precision of the HFWorks simulator, we ought to compare the simulations’ results to measurements. The following figures show the insertion and return losses of the structure from 1 to 4 GHz.

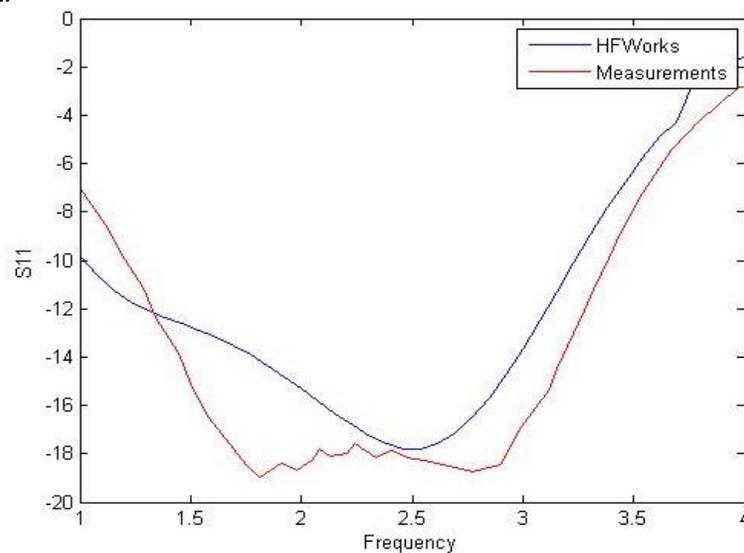


Figure 3: Reflection coefficient at the balun’s input port

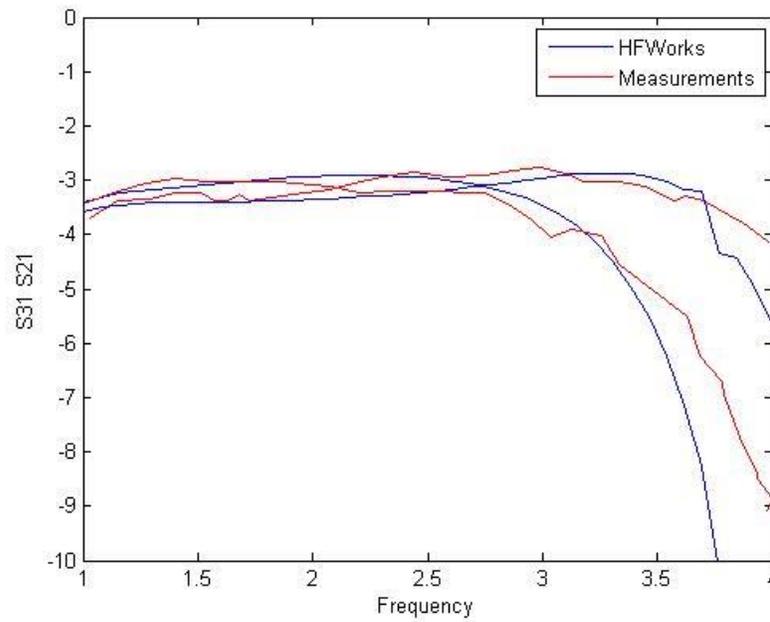


Figure 4: Insertion loss at the balun's output ports

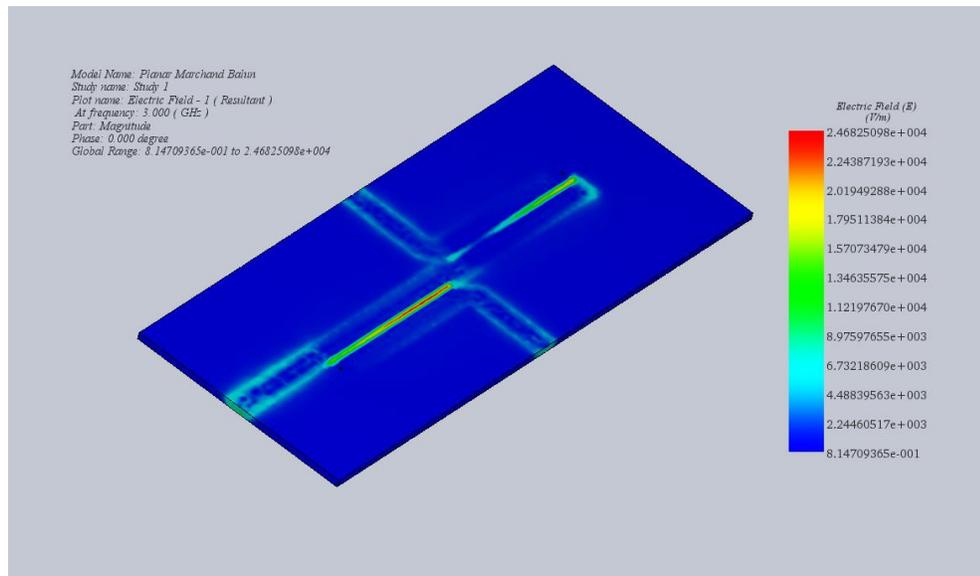


Figure 5: 3D electric Field Distribution at 3 GHz

## 5. References

- [1] A New Planar Marchand Balun Zhen-Yu Zhang, Yong-Xin Guo, L.C. Ong, and M.Y.W. Chia 2005 IEEE