

## Divider in Substrate Integrated Waveguide Technology

### Introduction

This application presents capabilities of WIPL-D software suite for full wave electromagnetic simulation of waveguide divider realized in substrate integrated waveguide technology, along with simulation results and requirements.

WIPL-D is modern and extremely efficient Method of Moments full wave 3D EM simulator. Its advantages are based on the fact that it applies quadrilateral meshing to EM models, and supports mesh elements of large size (up to 2 wavelengths). This is based on usage of higher order basis functions, allowing mesh elements of both small and large size within the same model.

The divider in wave guide technology is moderate size model with certain smaller details, so WIPL-D advantages are pronounced in full extent. The simulation model has low number of mesh elements and low number of unknown coefficients needed to determine current distributions. The code executes rather quickly on inexpensive CPU or GPU platforms thanks to excellent parallelization capabilities.

### Model Description

The simulation model of the waveguide divider originates from the provided CAD file, imported into WIPL-D Pro CAD. The upper cover is not shown to illustrate the geometry of the model and the mesh. The device operates at 60 GHz.

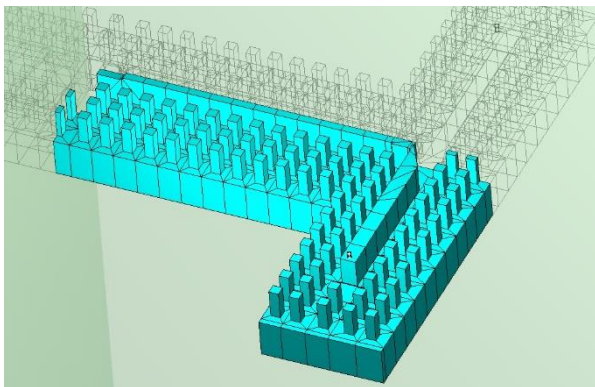


Figure 1 The simulation model

The model is symmetrical so only quarter of the model is shown. This dramatically saves resources and simulation time.

### Feeder Mechanism

The main port (the port from which the power is divided to 4 receiving ports, referred as port #1) is a standard waveguide port. Remaining 4 ports are specific ports feeding the ridged waveguide. Since these are not standard ports, the specific procedure was developed to analyze them accurately. WIPL-D determines the port characteristic by using the completely automatic de-embedding procedure. The feeder is closed with

PEC and then PMC plane. Next the feeder is extended and then again closed with PEC/PMC plane. Such a procedure yields accurate feeder characteristic which is then used to remove the influence of feeder to the entire model simulation and obtain proper s matrix.

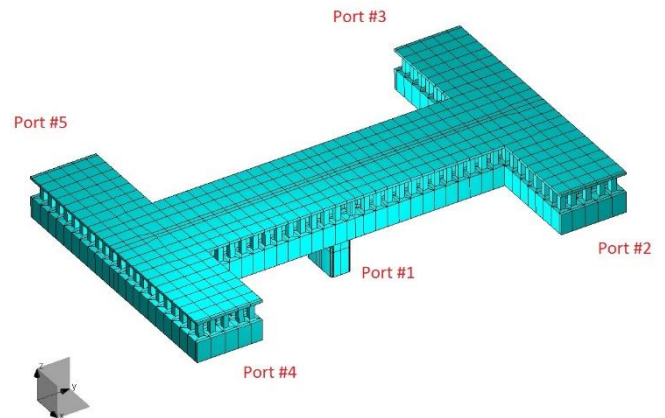


Figure 2 The numeration of ports

In this case, we have developed a customized but simple model for the feeder where the feeder is extended for the length of single post and then closed with PEC/PMC, which allows the code to determine exact waveguide feeder characteristic. The basic and extended feeder are shown in Figure 3.

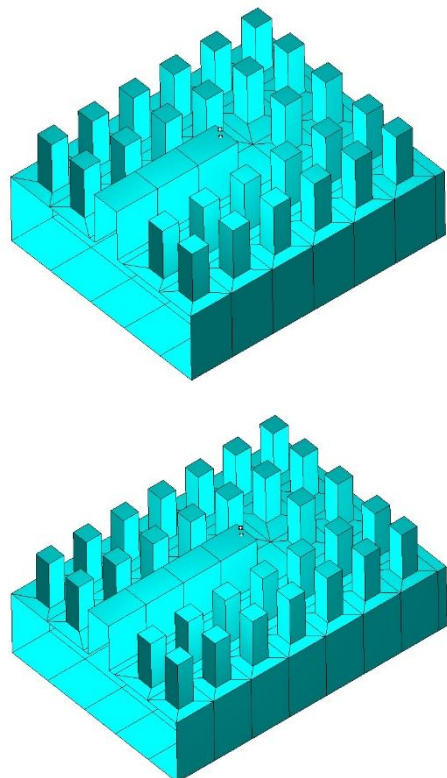


Figure 3 The feeder model (basic and extended)

As Fig 3 shows, the extended model is exactly the same as basic model, extended for the length of single row of posts. Such a feeder can be slightly tuned to provide excellent return loss and very low insertion loss by trying a few positions of the feeding wire located on the ridged waveguide.

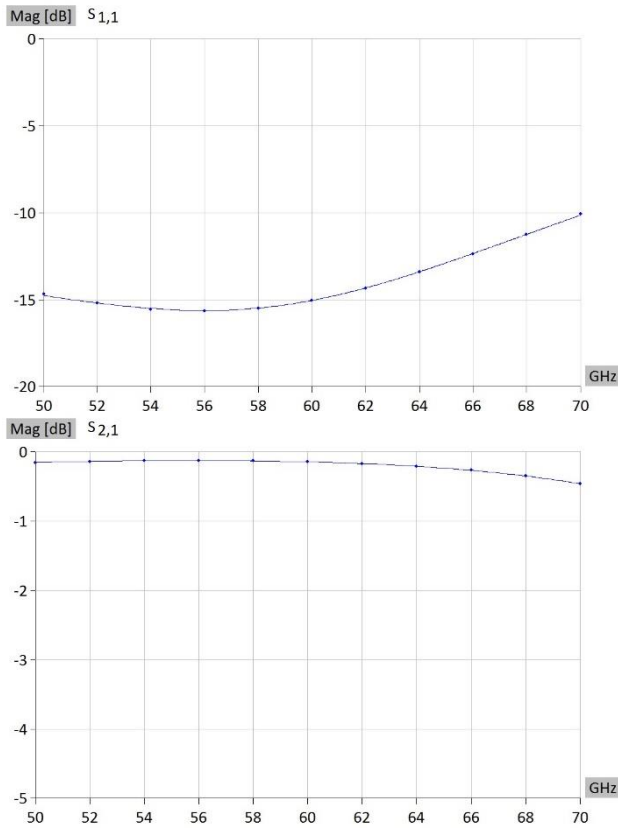


Figure 4 Return and insertion loss of the customized feeder

After the exact feeder characteristic is removed from the entire model (includes standard rectangular waveguide at port #1 and four feeders as shown in Fig 3 at ports #2-5), the return and transmission loss of the network can be accurately determined.

### Simulation

After performing the de-embedding as described in previous sections, return loss at port #1 is shown in Figure 5, along with the transmission from port #1 to port #2, return loss at port #2 and coupling between ports #2 and #3. Owing to symmetry, the transmission from the port #1 to ports #2-5 is identical.

The simulation is carried out by using only CPU technology considering the fact that the model is not electrically large. The simulation requires only 8,100 unknown coefficients in MoM matrix, but it is carried out 4 times to generate results for all 5 ports (model symmetry). The appropriate linear combination of responses of 4 subprojects (combination of PEC and PMC planes) enables efficient calculation of overall YZS parameters. Feature is completely automatic and does not require user intervention. The total simulation time per frequency point is 39 sec on multicore desktop PC:

Intel® Xeon® CPU E5-2650 v4@2.20 GHz (2xCPU, total: 24 cores)

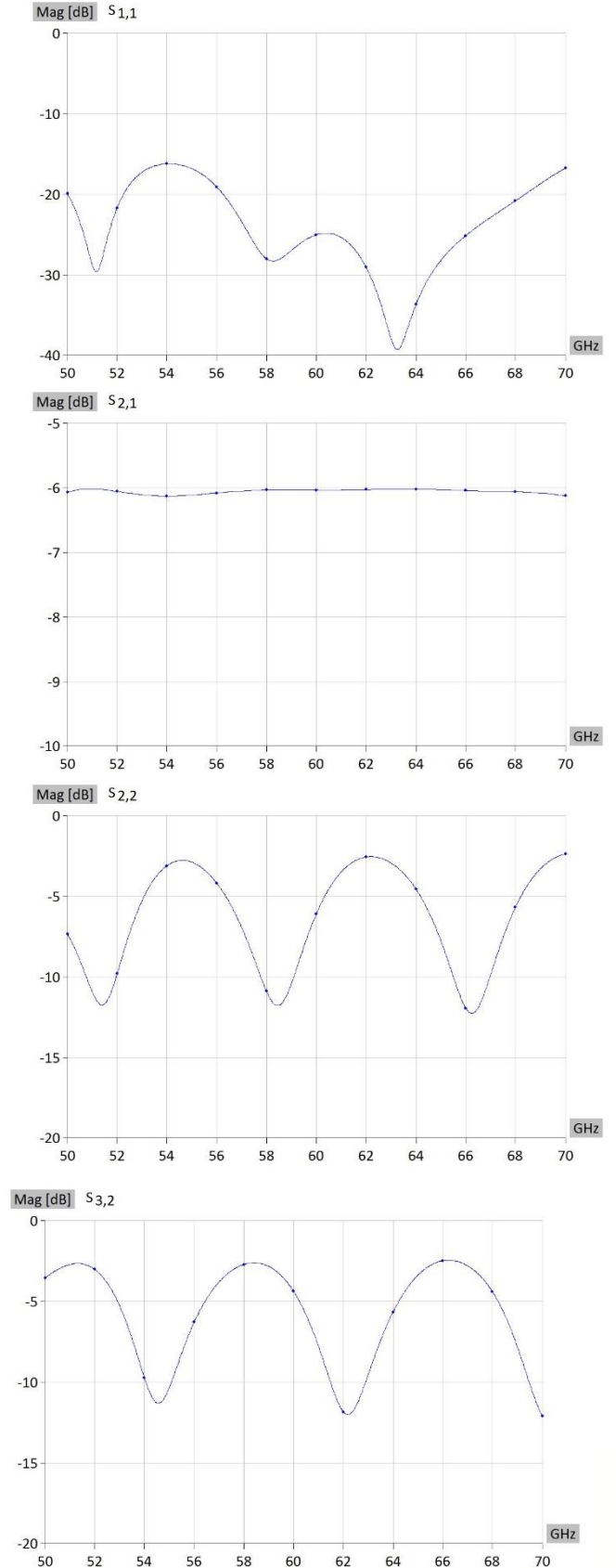


Figure 5 Return loss and transmission loss