# Modeling of a Magic Tee Waveguide Coupler

A short depiction of FEKO's waveguide capability with a magic T coupler as example.

## Background Information on Magic Tees

FEKO provides microwave engineers with the tools to simulate waveguide problems, enhancing understanding of real world problems. These tools have been applied to simulate a magic tee for the WR-90 waveguide band (X-band). Figure 1 depicts an annotated CADFEKO model for the magic tee.

The magic tee is a four-port, 180° hybrid splitter, realised in waveguide. Like all of the coupler and splitter structures, the magic tee can be used as a power combiner or a divider. It is ideally lossless, so that all power into one port can be assumed to exit the remaining ports. A signal incident on the sigma port (port 1) splits equally between ports 3 and 4, with the resulting signals being in phase. On the other hand, a signal incident on the delta port (port 2) also splits equally between ports 3 and 4, but the resulting signals are 180° out of phase. Ports 3 and 4 are sometimes called the co-linear ports as these are the only two ports that are in line with each other.

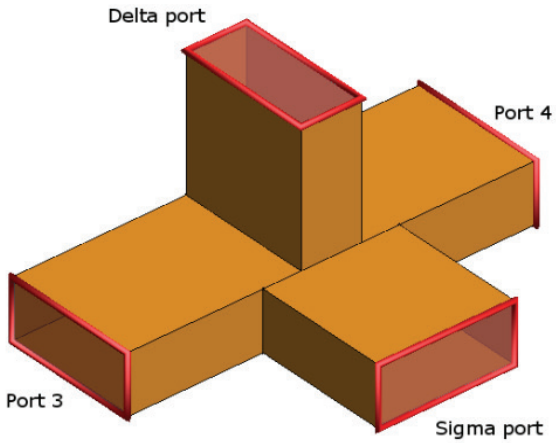



*Figure 1: CADFEKO magic tee model*

## Simulation Scenarios

The magic tee depicted in Figure 1 was simulated in FEKO for two scenarios:

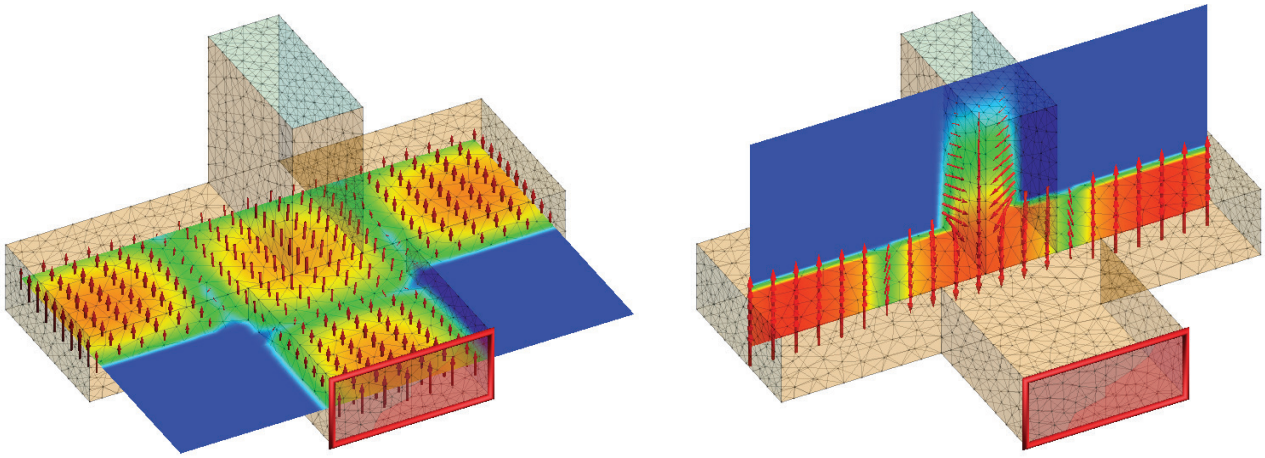
- Driving the sigma port (port 1) with a FEM modal excitation
- Driving the delta port (port 2) with a FEM modal excitation

The results that are presented below depict the following for both scenarios:

- Standing wave patterns with phase indicated by arrows
- S-parameter plots depicting the phase difference between ports 3 and 4

# Simulation Results

## Sigma port driven

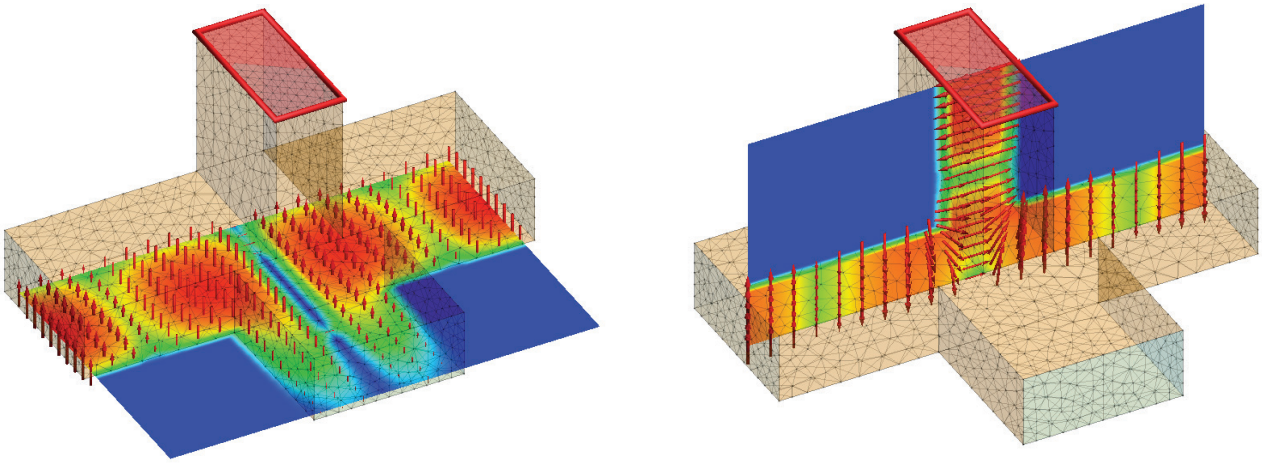


*(a) Horizontal plane plotted* *(b) Vertical plane plotted*

*Figure 2: Sigma port driven - standing wave patterns*

Inspection of the phase of the standing waves in Figure 2(a) shows that the energy flowing out of ports 3 and 4 are indeed in phase. Figure 2(b) illustrates that almost no energy is transmitted to the delta port when the sigma port is driven.

## Delta port driven

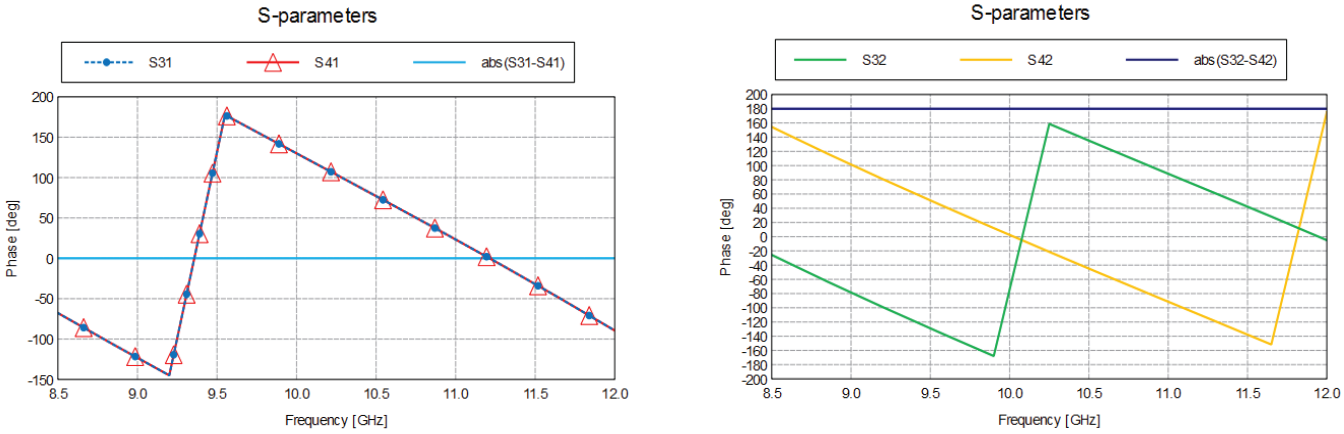


*(a) Horizontal plane plotted* *(b) Vertical plane plotted*

*Figure 3: Delta port driven - standing wave patterns*

Inspection of the phase of the standing waves in Figure 3(a) shows that the energy flowing out of ports 3 and 4 are indeed out of phase. Figure 3(a) also shows that almost no energy flows to the sigma port while the delta port is driven as indicated in Figure 3(b).

## S-parameters




*(a) Sigma port driven*

*(b) Delta port driven*

*Figure 4: S-parameter phase comparison between ports 3 and 4*

Inspection of Figure 4(a) reveals that ports 3 and 4 are always in phase when the sigma port is driven, while inspection of Figure 4(b) reveals that ports 3 and 4 are indeed always 180° out of phase when the delta port is driven.