



Modeling of a Magic Tee Waveguide Coupler

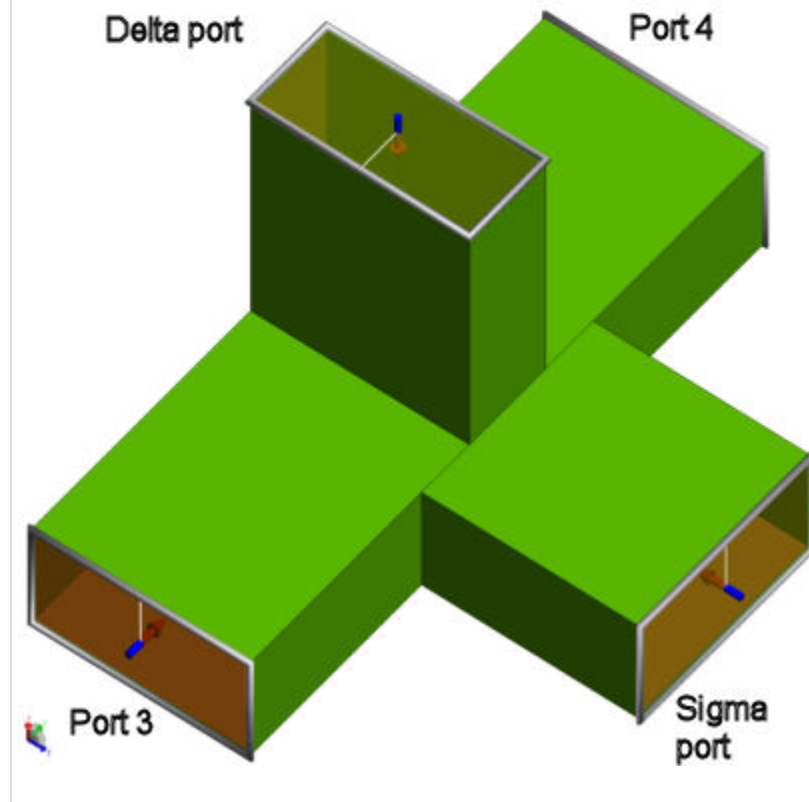
A short depiction of FEKO's waveguide capability with a magic T coupler as example.

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, realized 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:

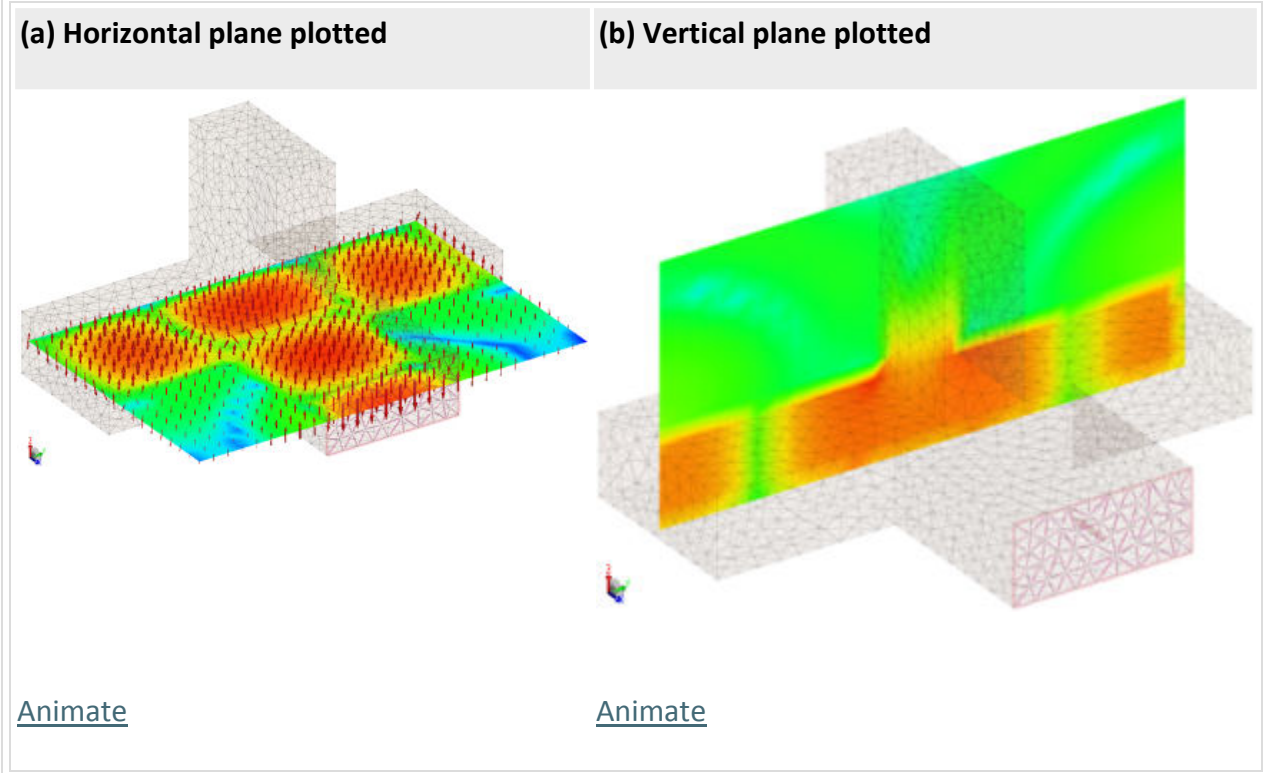
- Driving the sigma port (port 1) with a waveguide source.
- Driving the delta port (port 2) with a waveguide source.

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

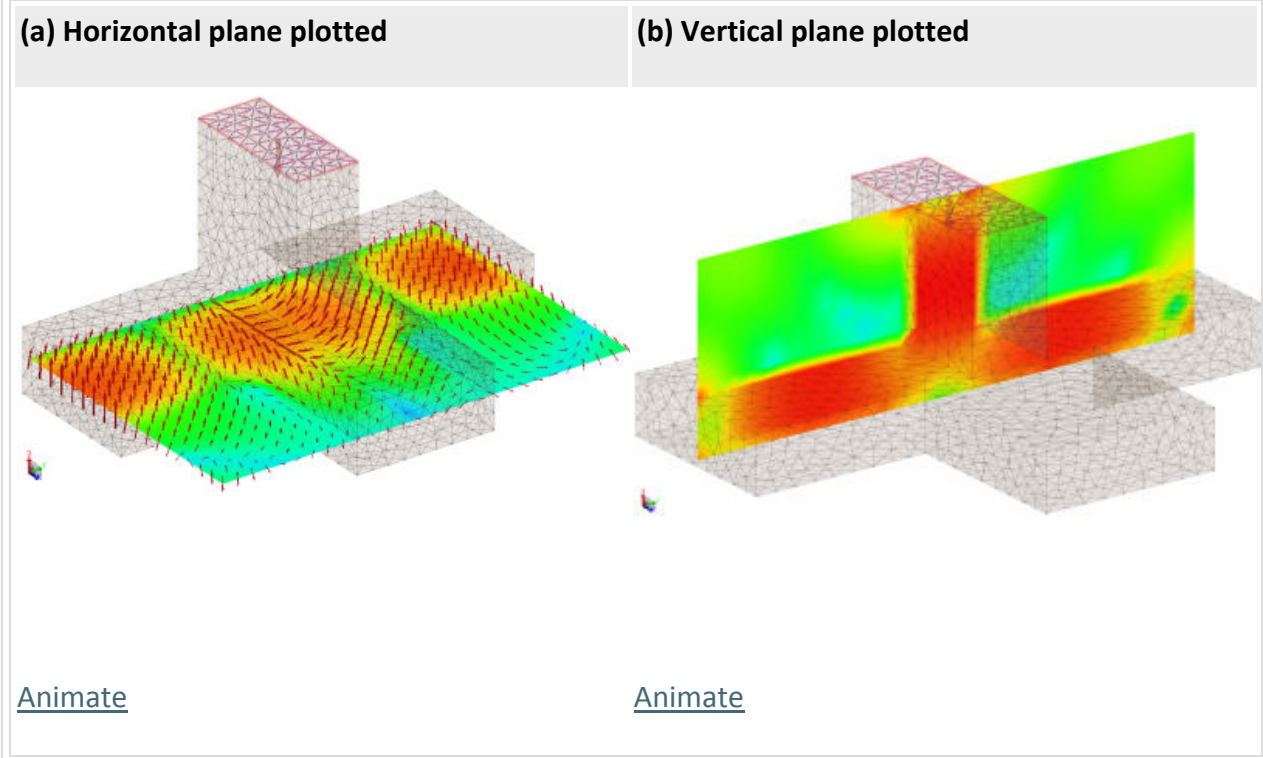
Figure 2: Sigma port driven - standing wave patterns



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

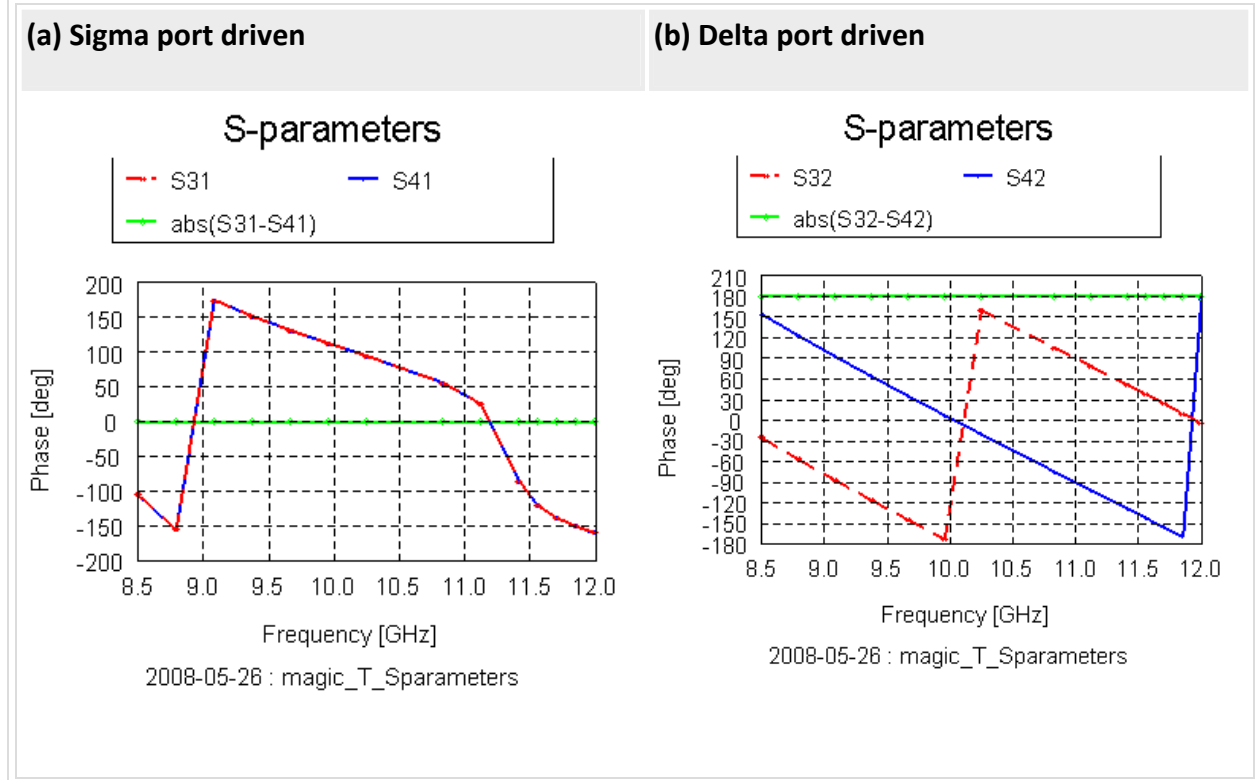
Figure 3: Delta port driven - standing wave patterns



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

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.