A Waveguide-to-Microstrip Transition for a mm-Wave Mixer Test Jig

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INTRODUCTION

Many space missions operating above 100 GHz are using heterodyne receivers, which require Schottky diodes. The development of Schottky diode devices is important, not only for space instruments but also for the emerging terrestrial applications in millimeter wave imaging.
So far the Schottky diode characterisation has been done on test carrier substrates, where the discrete diodes are mounted. The diodes are characterised by S-parameter measurements, direct current measurements and capacitance measurements. However it would be important to test the diodes in the actual operating environment of the diodes in final application, so that different Schottky diodes can be compared properly. The purpose is to develop a waveguide mixer test jig for characterisation of different Schottky diodes at the G-band frequencies.

MIXER TEST JIG

The idea is to build a mixer test jig where different diodes could be operated at their ultimate mixer performance under comparable conditions at high millimeter wave frequencies. The main focus is here in our case in G-band testing and especially testing at 183 GHz. One important requirement is that the structure of the mixer test jig should be as simple as possible. The diode will be mounted on a substrate with no impedance matching, and with only a waveguide probe and minimal filtering. The RF and LO signals are fed into the same waveguide and the probe couples the signals onto the diode substrate, which is positioned in a microstrip channel. The RF and LO impedance matching will be done with a low-loss waveguide tuner and the IF impedance will be matched with a coaxial tuner. DC and IF connections will be provided in a manner that allows the change of the substrate and the diode in the mixer.

WAVEGUIDE-TO-MICROSTRIP TRANSITION AND LOW-PASS FILTER

A waveguide-to-microstrip transition is an important part of the mixer test jig. The transition should be low-loss and broadband. The dimensions of the microstrip channel, where the diode is positioned, were determined so that only the fundamental mode propagates and the waveguide modes are at cutoff [1]. The transition extends through the WR-5 waveguide. In one end there is the microstrip channel, where the diode is mounted and in the other end there is the low-pass filter. The low-pass filter is needed to

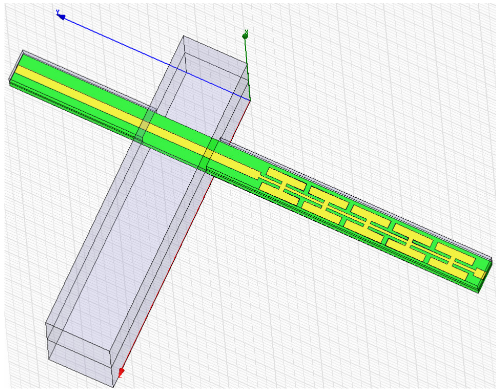

Figure 1: Waveguide-to-microstrip transition with low-pass filter.

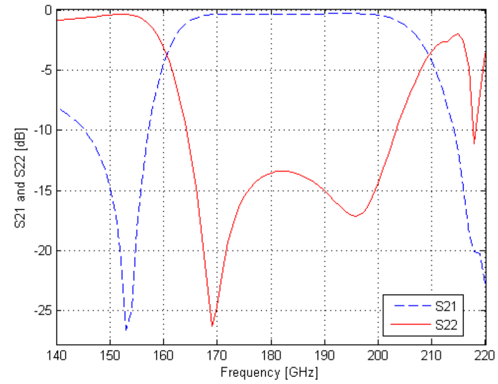

Figure 2: Simulated S_{21} and S_{22} of the transition at the microstrip port.

prevent signals at the RF and LO frequencies from getting into the IF port while only DC and IF frequency signals pass through. The designed and simulated low-pass filter is a hammerhead filter. The filter for 216 GHz in [2] was used as basis for the low-pass filter. The dimensions of the filter were modified so that the stop band is at correct frequencies (at RF and LO frequencies). Fig. 1 shows the waveguide-to-microstrip transition and the low-pass filter. Fig. 2 presents the simulated transmission and return loss of the transition from waveguide port to microstrip port.

CONCLUSION

A waveguide-to-microstrip transition with a low-pass filter for mixer test jig has been designed and simulated. According to simulations with dielectric loss, conductor loss and surface roughness of the metallization, the minimum return loss is 13.4 dB and the maximum transmission loss is 0.36 dB in the range of 170-200 GHz. The return loss was meant to be better, but it would have been reached only by narrowing the bandwidth. Another manner would have been reducing the height of the waveguide, but it would have made the manufacturing more difficult and the purpose was to keep the transition as simple as possible. Next step in the work is to simulate the transition with a diode model and tuners.

ACKNOWLEDGEMENT

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