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PTFE and Quartz Based 60 GHz Patch Antennas

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Abstract—**A 60GHz microstrip patch antenna arrays based on two different substrates utilizing different feeding types are presented. The simulated and measured results are in good agreement. Antenna arrays are designed for use in a millimeter-wave wireless communication system.**

I. Introduction

Due to the wide available spectrum the 60 GHz band can be used to realize the multi-gigabit wireless systems [1]. Antenna design and integration with other devices is a challenging task for such high frequencies. The research has been made to create a reliable and non-expensive antenna for the integration with the developed circuit module [2]. Two widely used substrates have been chosen to fabricate antennas: PTFE and quartz [3]. The former is used for the planar, direct fed patch microstrip array with 16 elements. The latter is used for two layers slot coupled patch array, having 4 elements. Measurement results are in good agreement with simulation results obtained using CST Microwave Studio.

II. Summary of Results

The planar microstrip antenna is built on PTFE (polytetrafluoroethylene) Arlon DiClad 880 substrate ($\varepsilon_r = 2.17$) with a thickness of 0.127 mm. Substrate is flexible and the fabrication process is relatively easy. Array consists of the rectangular patch elements excited by an inset microstrip line. The microstrip patch length is 1.5 mm, width is 2.3 mm, inset feed line distance is 0.3 mm. A corporate feeding network is used to form the 4x4 antenna array.

Two layers of quartz substrate ($\varepsilon_r = 3.75$) with a thickness of 0.2 mm each are used to build 2x2 microstrip patch array. The corporate feeding network and square patches are situated on the different quartz layers with a metal ground plane in between them. Rectangular slots in a ground plane are used to excite patches. The microstrip patch side is 1 mm, the rectangular slot length is 0.6 mm and width is 0.3 mm.

The antennas scattering parameters have been measured using 67 GHz Agilent E836A PNA. The antennas were fed through a 2.4 mm connector from Southwest Microwave company. In Fig. 1 is shown the return loss for 16 elements array, together with the fabricated antenna photograph. The estimated 10 dB bandwidth is about 3.5 GHz. Fig. 2 shows normalized E-plane radiation pattern for the antenna on PTFE substrate. The estimated gain is about 19 dB.

Quartz based antenna bandwidth is about 2.3 GHz and gain is about 10 dB. Measured results confirm the reliability of the antenna.

A simple transmission test has been performed using PNA and two PTFE or two quartz antenna arrays.

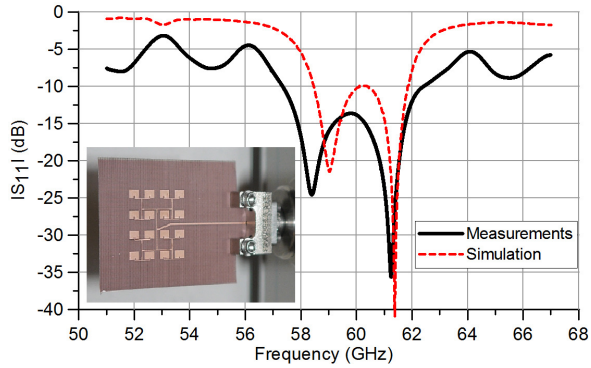

Figure 1. Return loss for 4x4 antenna array, fabricated antenna on PTFE substrate with 2.4 mm connector.

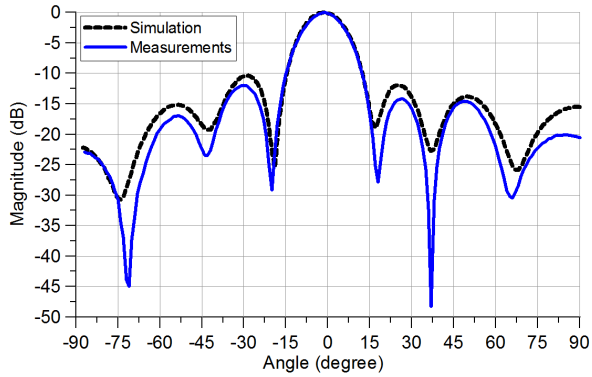

Figure 2. E-plane radiation pattern for 4x4 PTFE based antenna array.

III. Conclusion

Microstrip antenna arrays for 60 GHz on PTFE and quartz substrates have been designed, manufactured, and measured. The PTFE based 4x4 antenna array has a bandwidth of 3.5 GHz with gain of 19 dB. The quartz based 2x2 antenna array has a bandwidth of 2.3 GHz with gain of 10 dB. The antennas will be integrated with developed RF circuits. The future plan is to develop the antenna with improved characteristics based on the described prototypes.

References

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