Basic Study of a Ring Slot Active Antenna Integrating Gunn Oscillators for Spatial Modulation

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1 Introduction

We have proposed Gunn-oscillator integrated active antennas for spatial modulation systems [1]. In this paper, a new ring slot active antenna is proposed and its basic characteristics are experimentally studied.

2 Structure and Operation Principle

Fig. 1 schematically shows a concept of the spatial modulation system using polarization switching. Digital signals are carried by V and H polarizations.

Fig. 2 shows the structure of the proposed ring slot active antenna. It consists of a ring slot antenna and two Gunn oscillators employing a microstrip line resonator. The configuration of the antenna is very simple and it is suitable for compact wireless devices.

The length of the ring slot is two wavelengths at the design frequency. A Gunn diode is mounted at the center of the microstrip line resonator in each oscillator. The chip capacitors are mounted on the ring slot at half-wavelength intervals to make a short circuit at RF, then the ring slot is separated into four antennas. Four PIN diodes D1 to D4 are mounted on the ring slot antenna at half-wavelength intervals to switch the polarization. When D1 and D3 are ON state, polarization angle is 135 degrees. On the other hand, when D2 and D4 are ON state, the polarization angle is 45 degrees.

3 Experimental Results

Fig. 3 shows the measured polarization characteristics of a prototype antenna. Switching diodes in ON state are replaced by a pair of 47-pF chip capacitors in the measurement. For OFF state, circuits remain open. The solid line shows the measured result when the diodes D1 and D3 are ON, i.e., capacitors are mounted in the place of D1 and D3. Co-polarization is 135 degrees and cross-polarization suppression is 12.4 dB where the bias voltage and total current of the Gunn diodes were 5.4 V and 260 mA, respectively. The oscillation frequency was 10.07 GHz. The broken line shows the result when capacitors are mounted in the place of D2 and D4. In this case, co-polarization is 45 degrees and cross-polarization suppression is 15.7 dB. The bias voltage and total current of the Gunn diodes were changed to 5.7 V and 250 mA to obtain the same oscillation frequency.

There is a 3-dB difference between the maximum values of the solid and broken lines. This is because the oscillation condition was changed due to the fabrication error caused by hand soldering. The reason why different bias conditions are used in the two measurements is the same.

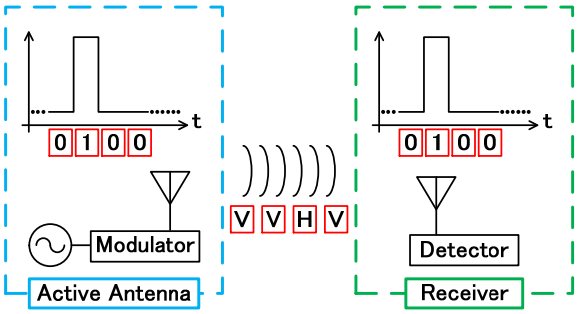

Fig. 1 Concept of the spatial modulation.

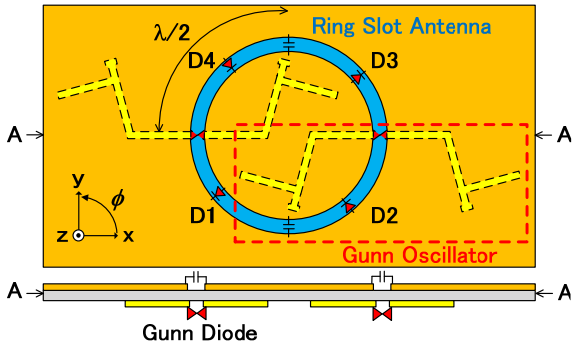

Fig. 2 Structure of the proposed active antenna.

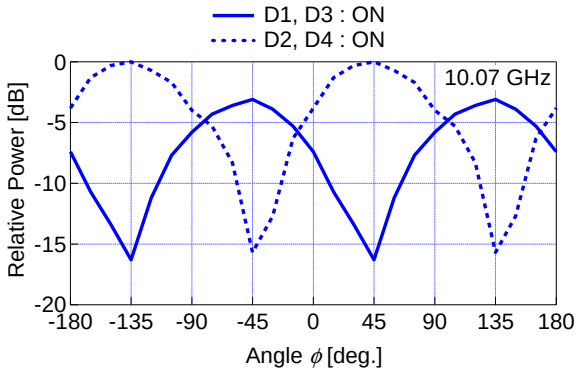

Fig. 3 Measured polarization characteristics.

4 Conclusion

A ring slot active antenna integrating Gunn oscillators for spatial modulation systems has been proposed and experimentally examined. The proposed polarization switching principle was found to be feasible.

References

[1] Y. Furukawa, E. Nishiyama, and I. Toyoda, “Basic Concept of an Active Array Antenna Integrated with Gunn Oscillator,” Rec. 2015 Joint Conf. of Electrical and Electronics Engineers in Kyushu, 07-2P-05, Sep. 2015.