Push-Pull Active Patch Array Antenna for Spatial Power Combining

Hidehisa SHIOMI, Keisuke NOHYAMA and Yasuyuki OKAMURA
Graduate School of Engineering Science, Osaka University
1-3 Machikaneyama-cho, Toyonaka-shi, Osaka, Japan 560-8531, shiomi@ee.es.osaka-u.ac.jp

Abstract

This paper presents an active integrated antenna with a dual-feeding push-pull patch. Two oscillators were mutually synchronized by symmetry of the push-pull patch with odd-mode excitation. The oscillator was designed using the maximum loaded oscillator method. The single patch antenna was oscillated at 5.48 GHz. The mesured directivity was in good agreement with the desired pattern. The E-plane two-element array was fabricated and measured. The two-element array antenna was oscillated at 5.13 GHz with even-mode operation.

1. INTRODUCTION

Electrically scanning high power transmitters have been required in many appricatios. In order to realize these transmitters, a spatial power combining array is one of promissing candidates. The spatial power combining array is realized by the radiative synchronized oscillators arranged periodically. Active integrated antennas are suitable for the radiative oscillator used in the spatial power combining array. This report describes the push-pull active patch antenna with a new configuration for robust synchronization.

The conceptional configuration of the spatial power combining array proposed is shown in Fig.1. A single patch with two oscillators is a minimal element factor of this array. The oscillators in the unit cell are the mutually synchronized as an odd-mode by the cavity mode of the patch and drive the patch antenna each other. The gate stub of the oscillator is connected to the oscillator for the synchronization with the direction of E-plane. The radiation patch shares the boundary with the next patch with the direction of H-plane. In this report, the unit cell and the 2-element E-plane arrays were fabricated and demonstrated.

2. UNIT CELL

The unit cell fabricated is shown in Fig.2 (l_g=1.8mm, l_d=4.8mm,l_s=14.7mm,l_p=15.0mm,w_p=16.0mm,l_a=5.9mm). The active patch was oscillated at 5.48GHz with $V_{ds1} = V_{ds2}$ of 1.4V, V_{gs1} of -0.4V and V_{gs2} of -0.1V. The single spectrum

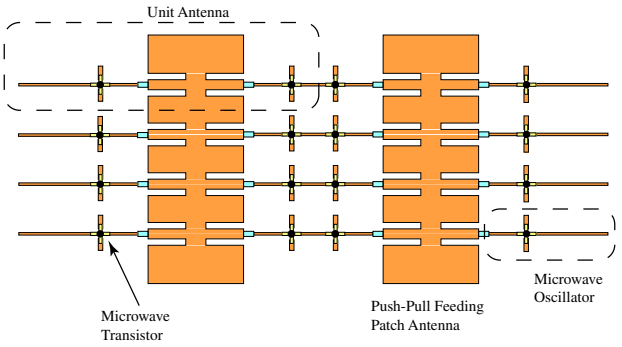

Fig. 1: Configuration of Push-Pull Active Patch Array Antenna

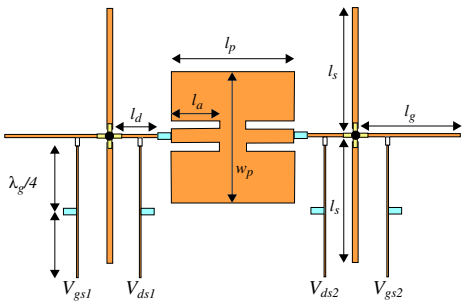

Fig. 2: Configuration of Fabricated Active Patch Antenna

was observed under the synchnonization. The double spectrum was observed when the gate voltage of the oscillator drastically changed for unlocking the synchronization. Figure 3 plots the radiation pattern of the unit cell. The measured pattern of H-plane was in good agreement with the prediction. However, the E-plane pattern shows the periodical fluctuation about 2dB, which is attributed to the diffraction from the edge of finite ground plane. The magnitude of cross polarization was less than the noise level. From these results, the unit-cell was oscillated with the desired mode.

3. TWO-ELEMENT ARRAY

The two-element array fabricated is shown in Fig.4. The common gate stub was provided to synchronize the oscillators. The length of the common gate stub was designd to be 3.9mm to oscillate 5.4GHz, however the actual frequency was

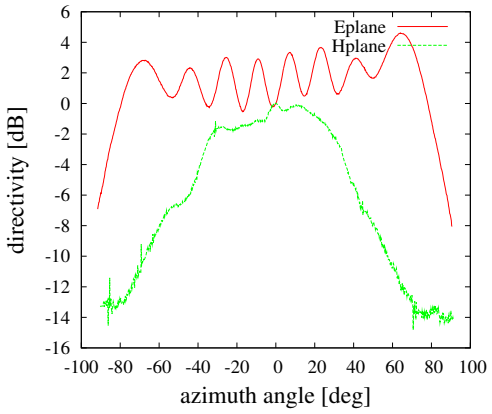

Fig. 3: Radiation Pattern of Active Patch Antenna (Co-pl.)

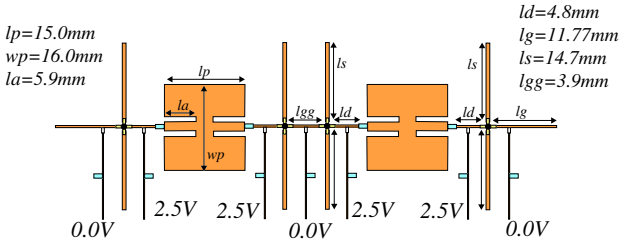

Fig. 4: Configuration of Fabricated 2-Element E-pl Array Active Patch Antenna

5.136GHz with V_ds of 2.5V and V_gs of 0V. Figure 5 shows the radiation pattern of the two-element array. From this figure, the main beam of the array directed toward to the broadside with the even mode synchronization. The fabricated antenna was operated under the desired mode.

4. CONCLUSION

This paper demonstrates the push-pull active patch antenna. First, the unit cell was fabricated, and measured. The fabricated antenna oscillated at 5.48GHz. The radiation pattern indicates the desired mode operation. Next, two-element array was fabricated. The array oscillated at 5.13GHz. From the radiation pattern the even mode operation under synchronization was indicated. These results are useful to design the electrically steerable high power microwave transmitters using the spatial power combining array.

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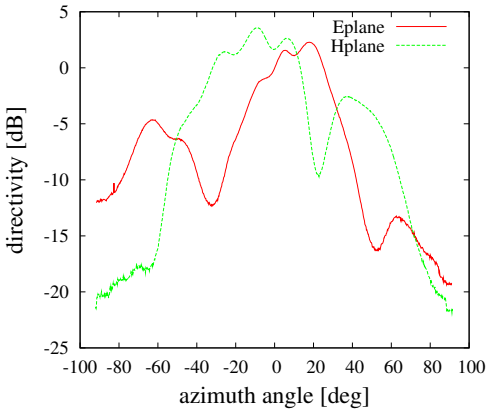

Fig. 5: Radiation Pattern of Active Patch Array Antenna (Co-pl.)

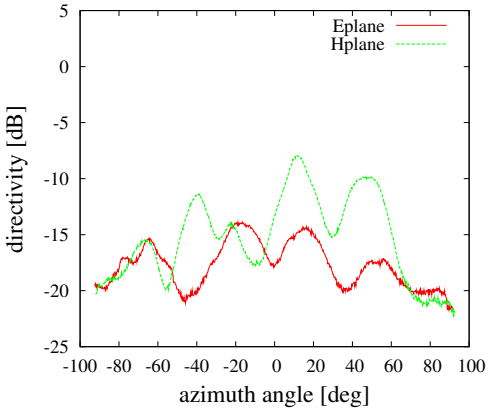

Fig. 6: Radiation Pattern of Active Patch Array Antenna (Cross-pl.)

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