

Radiation Characteristic of Tapered Slot Antenna with 3dB 180° Hybrid Coupler

Kuniaki Suto, Akinori Mastui

Saitama Institute of Technology, Graduate School Department of Electronic Engineering,
1690 Fusaiji Fukaya-shi Saitama, 369-0293 Japan

Abstract - Radiation pattern and gain of tapered slot antenna are measured with 3dB 180° hybrid coupler in order to feed balanced current. The radiation patterns show the radiation from the only radiator and agree with the simulation. The gain is obtained as same as the simulation. This method is effective to know the radiation from balanced radiator.

Index Terms — Tapered Slot Antenna, Radiation Characteristic, 3dB 180° Hybrid Coupler.

I. INTRODUCTION

Tapered slot antenna (TSA) is planar balanced antenna, which need balance-unbalance transition (balun) to connect to unbalanced measurement system or devices. In former articles, the radiation characteristics of TSA contain the characteristic of the balun. The report which mentions the radiation from the only radiator is few. The measurement method of the matching with 3dB 180° hybrid coupler (HYB) has been reported [1]. We focus on the method and apply to the measurement of the radiation pattern and the gain of the TSA in this article. This is able to be measure the radiation from the only radiator which is suppressed the influence of the unwanted radiation from the balun. The measurement result is compared with the simulated result by electromagnetic simulator WIPL-D Pro by moment method. We will be able to be quantitatively study about unwanted from the feed system by the discussed method. Furthermore, the matching characteristic tics have been achieved by S-parameter method and shown the validity with the simulation [2].

II. CONFIGURATION

Figure 1 shows the configuration of test TSA. The operating frequency bandwidth is limited by the bandwidth of the HYB and the measurement instruments. Because the wide band operation is the feature of TSA, the bandwidth is planned to perform from 4 to 11GHz. The TSA is designed in the part of the length (l_a+l_c) and the width w . The taper curve is linear and the feeder is coplanar strip line (CPS). The lowest performed frequency is set at 3GHz. The part of the length l_j and the width w is a measuring jig and is considered as the part of the measuring system. The jig is composed of two microstrip lines (MSL) with the characteristic impedance of $Z_{msl}=50\Omega$. Because MSL is used in the jig, there is copper

metal plane in the only back of the MSL. All parts are composed on PTFE substrate (dielectric constant $\epsilon_r=2.6$, thickness $h=0.6\text{mm}$)

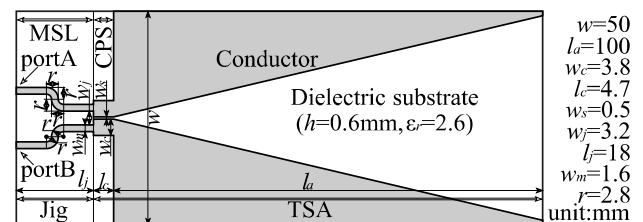


Fig. 1. Configuration.

III. MATCHING CHARACTERISTIC

The matching characteristic of the test TSA by S-parameter method (meas.) is indicated in Fig. 2. The simulation results by WIPL-D Pro (sim.) are also shown. In the simulation, the model of the TSA is only the radiator and doesn't contain the jig. The reference impedance of the input port of the CPS becomes 100Ω since the feed is performed by HYB with the characteristic impedance of 50Ω . The width between two strips of the CPS is set at 0.5mm . The experiments are compared with the simulation in Fig. 2. The matching almost satisfies in $VSWR < 2.0$. The small degradation is observed at 8.6GHz, 10GHz and near but we suppose that is not seriously influenced to the radiation measurement. We measure the radiation patterns and the gain of the TSA as following.

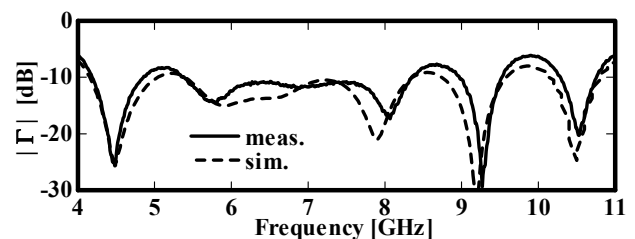


Fig. 2. Matching characteristic.

IV. MEASURING SYSTEM FOR RADIATION

Figure 3 shows the measuring configuration for the radiation. The X and Y ports of the HYB are connected to the test antenna via SMA adaptors. Sum port (Z) is terminated in

50Ω. Radiation patterns are measured by this configuration fed from the difference port (W). The 3dB 180° HYB applied in the experiments is CHC0412U91K of CERNECWAVE, which is designed to work from 4 to 12GHz. The evaluation of the test HYB with the jig is shown in Fig. 4. The ports of the S parameters in Fig. 4 correspond to the ports of the HYB in Fig. 3. The isolation of the HYB is -24.8dB at 4.44GHz in the maximum. The amplitude difference between the ports is ±0.2dB and the phase difference keeps within 20° to 180° at 4 to 11GHz.

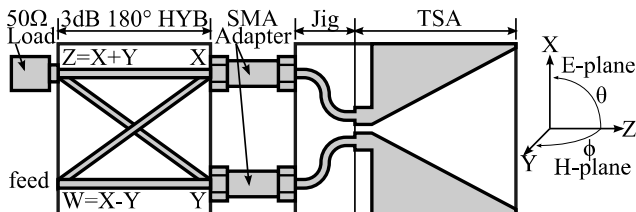


Fig. 3. Matching characteristic.

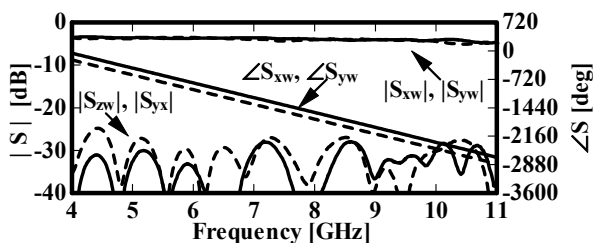


Fig. 4. Characteristic of the HYB.

V. MEASURING RESULT

The radiation patterns on the experiment and the simulation are illustrated in Fig. 5. The description about E and H planes and the expression of the angle is explained in Fig. 3. The TSA shows mono directional radiation, which radiates for the aperture of the TSA, 0°. On the other hand, the back side shows as 180°, which is the input port side. Because the radiation shows symmetric radiation in the each plane, we can consider that the TSA is fed by balanced current from HYB. On the comparison with the experiments and the simulation, the bore sight patterns and the angle of the null points are agree but 180°±45° region in the H plane at 7GHz. The radiation patterns from the only radiator have been measured by this combination procedure from above discussion. The test TSA doesn't show the feature of mono directional radiation at 4GHz, especially in E plane. The radiation more than 7GHz shows mono direction and the antenna performs as conventional TSA. We can consider that the effective radiation as TSA present in more than 4GHz in this case. Gain is measured by comparison method with standard gain horn antennas, which are 4.0-5.2GHz, 5.2-8.0GHz, 8.0-11.0GHz. The gain, which increases as frequency, is 3.8dBi at 4GHz and 11.2dBi at 11GHz and

agrees with the simulation within the difference of 1.0dB in the bandwidth. The biggest difference between the experiment and the simulation is 1.1dB at 10.0GHz.

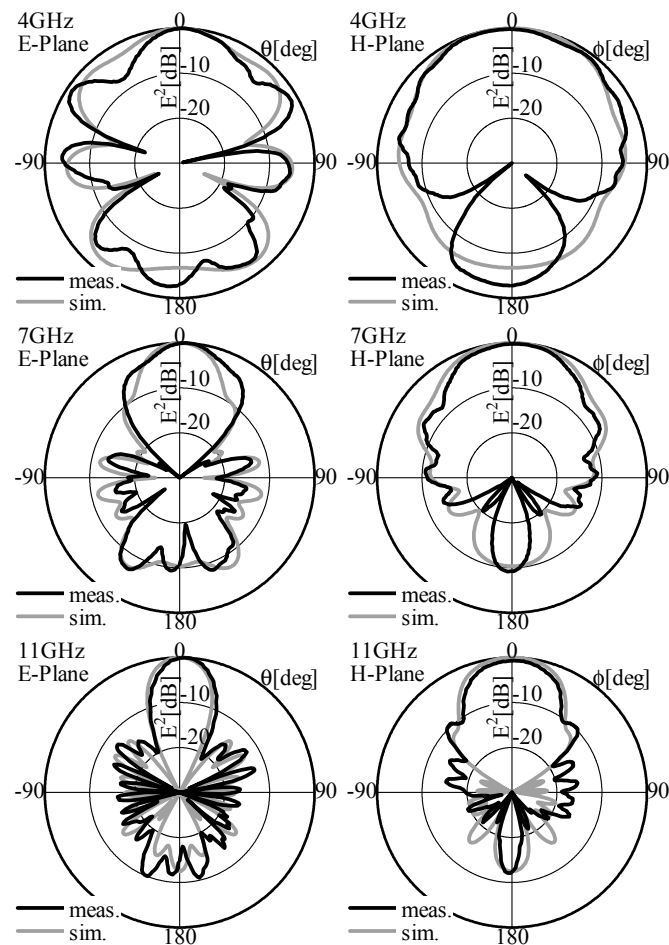


Fig. 5. Radiation pattern.

VI. CONCLUSION

The radiation characteristic of the TSA as balanced antenna has been measured with 3dB 180° HYB. The results have not influenced by the transmission characteristic and the unwanted radiation of the balun. It is the future challenge that the effect of HYB is discussed in detail and the radiation pattern is studied in various taper curves of the radiator.

REFERENCES

- [1] M. Hayakawa and N. Ishii, "Evaluation of Balanced Dipole Antenna Using Balanced and Unbalanced Modes," *IEICE Trans. Commu.*, vol. J96-B, No. 9, pp. 1076-1085, 2013.
- [2] K. Suto and A. Mastui, "Input Impedance of Tapered Slot Antenna by S parameter Method," *2014 IEEE APS*, 329.3, July 2014.