Side Coaxial Connector Feed Design for a Millimeter-Wave Patch Antenna Measurement

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Abstract - **The evaluation of the radiation pattern of the antenna is important to design the wireless communication system. In the millimeter wave, the antenna size is smaller than the connector and feed pin. Therefore, a connector has to place in the side of the antenna, and has influence to the measurement result of radiation pattern. In this paper, the influence of the connector is discussed, and structure with small influence to radiation pattern is proposed. We simulate and measure the radiation pattern.**

Index Terms — **Millimeter wave antenna, Radiation pattern, Evaluation, Side coaxial connector feed.**

1. Introduction

Recently, antennas fabricated on the board are widely developed [1] for compact mobile wireless communication system. Especially, high frequency like millimeter-wave can achieve very small antenna. And, the on-board antenna becomes more widely and generally. The evaluation of the radiation pattern of the antenna is important to design the wireless communication system. In the evaluation, the connector and feed line are needed to connect measurement system like vector network analyzer. It's important to reduce the influence by those for the correct evaluation of the radiation pattern. Generally, the connectors is placed on the bottom side of the antenna board to exclude the connector from radiation area in the microwave frequency like 2.4GHz [1]. In that structure, the feed pin of connector has to directly connect to radiation element of the antenna. In the millimeter wave, the antenna size is smaller than feed pin and applying that structure is difficult. Therefore, side feed structure was applied. The structure has no limitation of the antenna size, but has influence to radiation pattern because connector is placed on the radiation area. In this paper, the influence of the connector is discussed, and structure with small influence is proposed.

2. Side Coaxial Connector Feed Design

(1) 60GHz patch

Figure 1 shows the cross-section of the 60GHz patch antenna composed on organic substrate (Panasonic MEGTRON-6), and simulation results of the antenna element. The feed point is located directly below of the thru hole of antenna board. To cover the frequency band of IEEE 802.15.3c, more than 15% bandwidth is required. The patch antenna with two parasitic patch layers [2] are employed to achieve the bandwidth. The antenna gain without connector and feedline are 4.2dBi and 4.0dBi at 30° and 45° in the E-plane, respectively. In the H-plane, the gain are 3.0dBi and 2.8dBi at 30° and 45°, respectively.

(2) Connector on E-plane

The electrical-magnetic (EM) simulation model and result of the conventional structure are shown in Fig. 2. The patch antenna shown in Fig.1 is used with feedline and connector. When a connector is placed on the E-plane, the feed line becomes shortest and straight because of feed point of the patch antenna is on the E-plane as shown Fig. 2 (a). Generally, the connector and feed line are placed on symmetric line of the antenna to keep the symmetry of the radiation pattern. In the millimeter wave like 60GHz, the connector is placed near the antenna to reduce the length and loss of the feed line. Therefore, when the connector is placed on the E-plane, the connector has influence on radiation pattern as shown in Fig. 2 (b). The radiation pattern on E-plane is warped to 90° direction more than ideal pattern as shown in Fig. 1 (c). The connector placed on the 270° direction, and reflect the electric field to 90° direction.

(3) Connector on H-plane

To measure the correct radiation pattern of the antenna, the connector position is changed as shown in Fig. 3. Because of the large ε_r of the connector, the connector on E-plane has substantial influence on electric field. On the other hands, an electric field becomes zero on the H-plane by symmetry of electric field. Therefore the connector on H-plane has no influence on electrical field of the antenna. Moreover, that has only little influence to magnetic field, because the connector is mainly composed by Cu and dielectric, so μ_r is nearly equal to 1. Figure 4 shows the configuration of the proposed structure. The connector and feed line are placed on the H-plane to reduce the influence to radiation pattern. The feed point of the antenna is not placed on the H-plane, so the feed line is designed in the slant direction to H-plane as shown in the bottom view. Figure 5 shows the measurement (solid) and simulation (dot) result of the proposed structure. The electrical radiation pattern around 90° could be measured correct by the proposed structure compared with Fig. 2(b). The connector and cable are cumber and the H-plane about 90° to 180° can't be measured as shown in Fig.5 (b), but there is no abnormal reflection in other area. The antenna gain with connector and feed line are 5.2dBi and 3.5dBi at 30° and 45° in the E-plane, respectively. In the H-plane, the gain are 0.9dBi and -9.6dBi at 30° and 45°, respectively.

3. Conclusion

In this paper, we discussed about the influence to the radiation pattern by the connector, and proposed structure with small influence to radiation pattern. The radiation pattern of the 60GHz patch antenna composed on the substrate was evaluated.

Acknowledgement

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References

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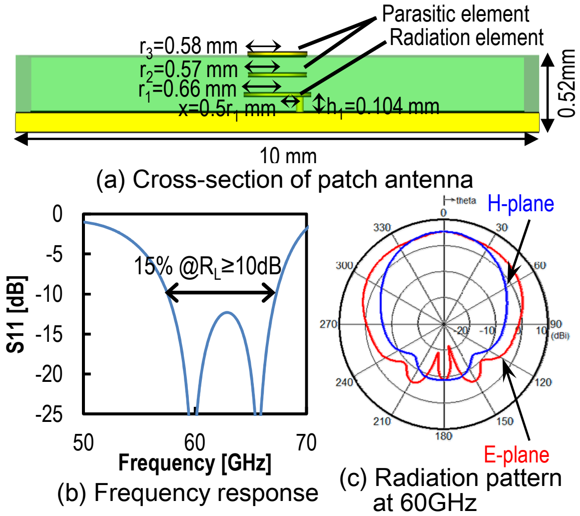

Fig. 1. Cross-section and simulation result of the patch antenna for 60GHz.

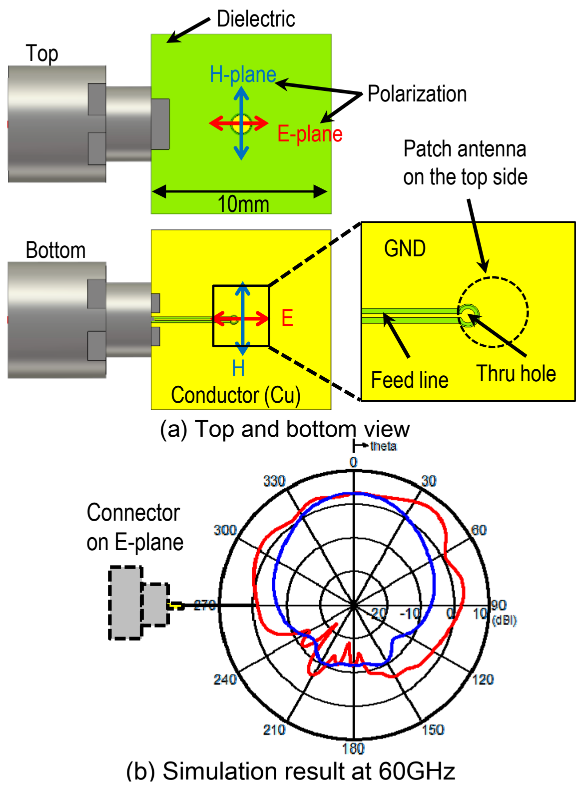

Fig. 2. Configuration of the conventional structure with connector and feed line on E-plane.

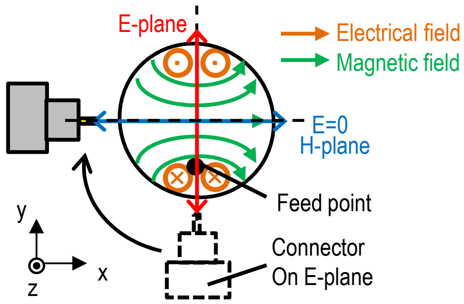

Fig. 3. The influence of the connector.

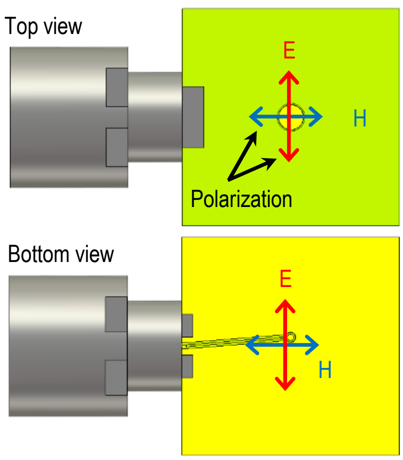

Fig. 4. Configuration of the proposed structure with connector on H-plane.

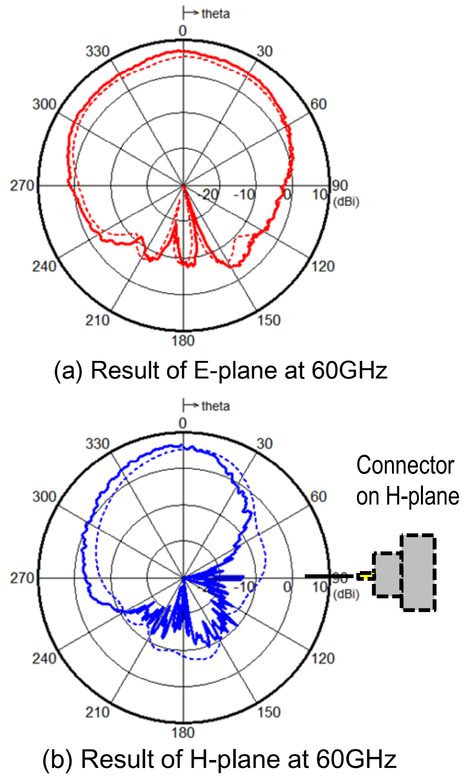

Fig. 5. Measurement (solid line) and simulation (dot line) result of the proposed structure.