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An Example of Millimeter-wave Band Antenna Measurement System with Optical Fiber Link Technologies

Yuanfeng SHE † Michitaka AMEYA Satoru KUROKAWA † Jiro HIROKAWA ‡ and Makoto ANDO ‡

† Electromagnetic Fields Section, National Metrology Institute of Japan (NMIJ), National institute of advanced industrial science and technology (AIST), Tsukuba, Ibaraki, Japan

‡ Dept. of Electrical and Electronic Engineering, Tokyo Institute of Technology, Meguro-ku, Tokyo, Japan

E-mail: † {yuanfeng.she, m.ameya, satoru-kurokawa }@aist.go.jp, ‡ {jiro, mando}@antenna.ee.titech.ac.jp

Abstract This paper evaluates the effect of the facilities such as the connect jig and the measurement system. An example of the millimeter-wave band antenna system with optical fiber has been introduced. The radiation patterns of a 60 GHz small package antenna has been measured by the optical fiber link system.

Keywords Millimeter wave; Small antenna; Antenna measurement; Optical fiber link technologies

1. Introduction

Engineers always meet such kind of problems in millimeter wave antenna design: when the fabricated antenna got a different performance as expected, it is difficult to detect whether it is the problem in products (antenna) or in facilities (measurement system). In [1], the uncertainty factors in both design and measurement are discussed. In this report, the authors will also take this 60 GHz small antenna [2] to discuss the uncertainties in antenna measurement.

In millimeter wave applications, the measured performance of the small antennas for the mobile terminals may different from expected. The main reasons of the difference may as Fig.1.

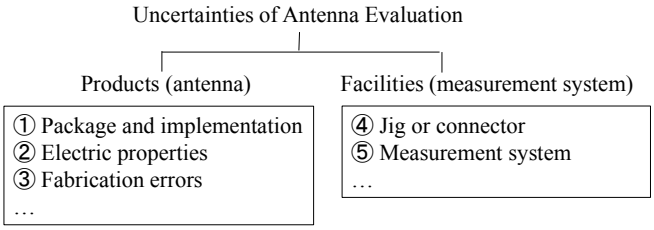


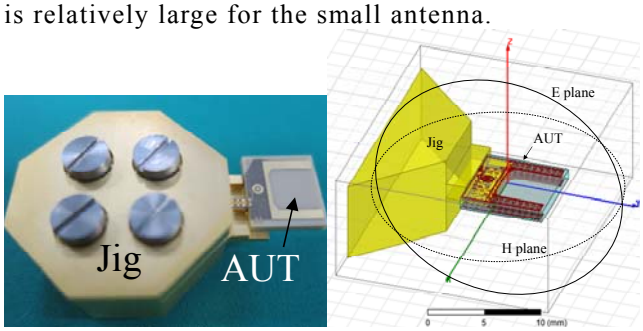
Fig. 1 Uncertainties of the antenna

The reason ①, ② and ③ are products problems. They cause the uncertainties in the expected performance (design) and the practical performance. The reason ④ and ⑤ is the facility problems. The engineers should redesign their antennas and consider to improve the antenna performance according to the factors ①, ② and ③.[3][4]

On the other hand, in order to evaluate the antenna performance, the evaluation about the measurement system is very important. There are many reasons of the uncertainties by the facilities, such as the jig, cables, the metal support flames, reflection of the absorbers and so on. Especially for the small antenna, the effect of the jig or connector should be carefully evaluated. And, the conventional measurement system usually uses metal coaxial cables. This report introduces an example of the millimeter-wave band antenna system with optical fiber to reduce the effect by the cable.

2. Evaluate with Jig

In the measurement, jigs or special transitions are often used to connect the antenna under test (AUT) and the system if the interfaces are different or it is difficult to connect them directly. The size of the jig is relatively large for the small antenna.



(a) Photo **(b)** HFSS model

Fig. 2 Small antenna with jig

Fig.2 shows the photo and the HFSS model of the AUT with the jig. AUT is fed by bonded wire while the measurement system is for the standard waveguide. The WG/CBCPW transition jig is necessary to connect the AUT and the standard waveguide. Thus, they should be evaluated together in the pattern measurement.

Fig.3 shows the effect of the jig to the radiation pattern in simulation. The black lines are radiation patters of the AUT with the jig while the blue lines are the patterns of the AUT without the jig. The solid lines show the E-plane pattern and the dashed lines show the H-plane pattern. The size of the jig is larger than the AUT. It works as a small reflector behind the AUT and enhance the gain of the AUT. So, as shown

as Fig.3, the beams of the AUT w/jig are narrower than those of the AUT w/o jig.

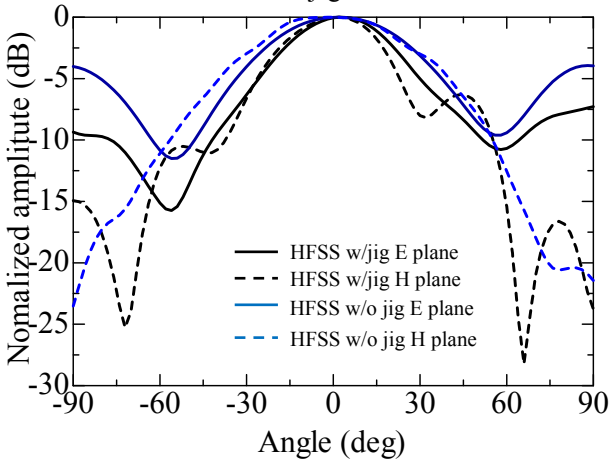


Fig. 3 Simulated patterns of the AUT w/jig and w/o jig

3. Measurement System

Table 1 Two Different Measurement system

System	System A	System B
Distance (m)	1.6	6.0
Receiver antenna	23 dBi std. horn	15 dBi std. horn
Step (deg)	1.0	1.0
Cable	Optical fiber	Coaxial
AUT set up	Support under antenna	Support behind antenna

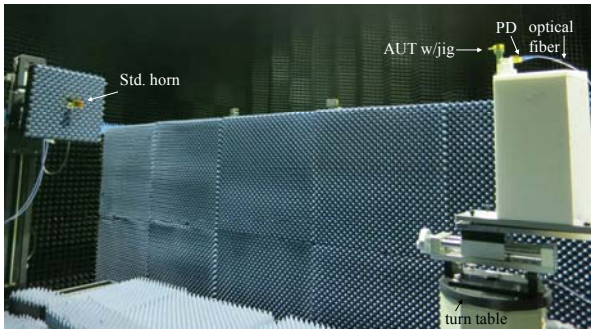


Fig. 4 Antenna pattern measurement system (system A)

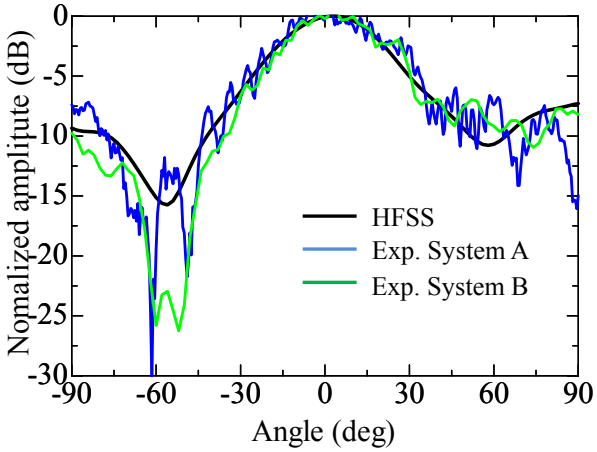


Fig. 5 E plane of the radiation patterns of AUT w/jig by two different measurement systems

The conventional antenna measurement system usually uses metal coaxial cables. Optical fiber link system can replace the metal coaxial cables and suppress the reflection waves from the coaxial cable. The radiation patterns of AUT w/jig is measured by the optical fiber link system (System A) as shown in Fig.4. As a comparison, it is also measured by a conventional system (System B). The differences of the setup of the system are shown in Table.1.

The measured E plane patterns by both systems have been compared with the simulated pattern in Fig.5. The envelope looks similar and the optical system seems has a better agreement in the side lobe. However due to the unstable source, it is difficult to conclude which system is better at this stage.

4. Future Work

The ripple measured by System A is larger due to the unstable source. Fig.6 shows the proposed system and outline of our system. [6]The future work of the measurement by the source will become stable.

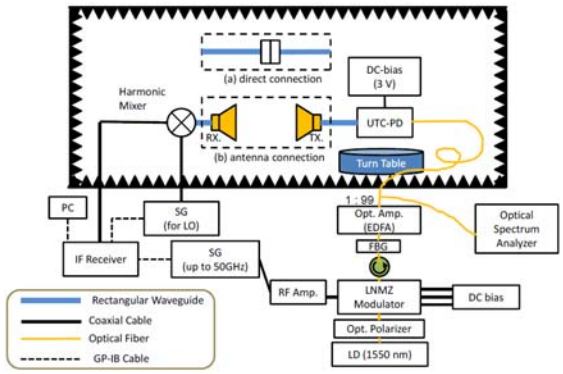


Fig. 6 Antenna pattern measurement system using nested MZ-LN and PD

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