Fast Spherical Near Field Measurement Method for Planar Phased Array

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***Abstract*-The measurement of phase array antennas is a new frontier of research on the millimeter wave (MMW) OTA tests. In the measurements of MMW phase array antennas, the spherical near field measurement technique is widely used and it is set as standard. The time-consuming spherical near field measurement is one of its drawbacks. In this paper, a fast spherical near field measurement method is presented. The measurement speed is greatly improved provided that planar phased array element arrangement is being measured.**

I. INTRODUCTION

In this paper, we propose a fast spherical near field measurement method for planar phased arrays. The radiation patterns of phased arrays are decomposed into the excitation factors (amplitude and phase) of each array element and the scattering and transmission factors of all the elements in the array. With the radiation patterns of each element and the element arrangement of the phased array provided, the scattering and transmission factors of all the elements in the array are known. By using larger scanning intervals (> λ /2), the unknown amplitude and phase excitation factors can be measured and calculated. Therefore, the time-consuming measurement of a planar array is simplified and the excitation of each array element can be obtained.

II. THEORY

The fast spherical near field measurement method for planar phased array is based on the spherical wave expansion [1] and general scattering matrix (GSM) [2] [3]. The spherical near field measurements speed is greatly affected by the sampling pattern, as well as the sampling time for a single scanning position. Generally, the sampling time for a single scanning position is determined by the mechanical and electrical system setup, and is almost fixed for existing systems. In the classic spherical near field measurement technique [1], the sampling pattern is based on equal intervals in ϑ and φ scanning, and the interval is determined by the number of spherical modes. The larger the number of spherical modes, the more sampling points are required, thus increasing the overall measurement time.

For a planar phased array, with its element arrangement and spherical coefficient of each individual element known a-priori, the measurement efficiency can be improved by GSM analysis of the measured planar array [3]. The spherical coefficient can be decomposed into complex incident excitation amplitudes for each array element and general transmission matrix that is related to the scattering and transmission characteristics of each array element and their mutual coupling effects. This method, though increases the measurement efficiency, introduces some potential errors that may degrade the measurement accuracy. The a-priori of the element arrangement and spherical coefficient of each individual element may not exactly be the same as the real phased array due to the simulation and manufacturing errors. It may have some impact on the antenna gain, the beam steering and side lobes level.

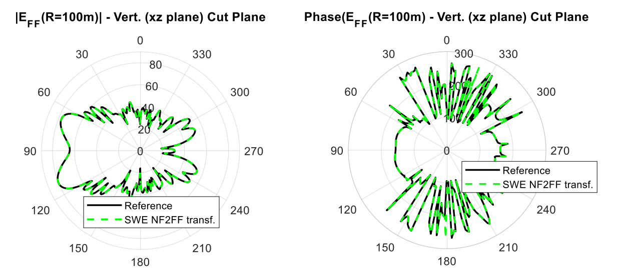

Fig. 1. The comparisons of amplitude and phase pattern between simulation and fast spherical near field to far field transformation.

III. SIMULATION RESULTS

In this section, a simulation is stablished to verify the fast spherical near field measurement method. A 500 around elements phased array working at 22.5 GHz with dipole-like antenna as the element. The maximum radius enclosing this DUT is 90mm, so the number of spherical modes from [1] is around 53, so the scanning interval in ϑ and φ direction over the full sphere is 3°, and the sampling points number is 14762. The measurement speed can be greatly improved by applying the proposed method based on the a-priori knowledge of the spherical coefficients of each individual element. The proposed technique scans the DUT in 15° interval, thus the sampling points number is 650 The comparison result is shown in Fig. 1.

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