An Automatic Measurement System of Antenna Phase Center Using the Binary Search Algorithm

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The three-antenna method is widely applied to determine the antenna gain. The distance between the antenna open ends is commonly used as the propagation distance. When the distance between the transmitting and receiving antennas are short–such as a 3-m radio anechoic chamber, the distance between the phase centers and the open ends of an aperture antenna is not negligible compared with the propagation distance. Since it is one of the dominant factor of uncertainty in gain measurement, precise determination of antenna phase centers is crucial. To reduce the uncertainty in gain measurement, an automatic system to determine the phase centers of aperture antennas in a radio anechoic chamber has been developed (Y. Tamaki et al., AMTA Symp., 2016).

The phase center of an antenna in defined as a center of a sphere the radiation of which extends into the far field; the phase of the radiation field over the sphere surface is essentially constant, at least over a rotation of the surface where the radiation is significant. The proposed automatic measurement system is to obtain the point automatically by using the measured phase pattern between the transmitting and receiving antennas. The system consists of the antenna under test (AUT) (transmitting), a two-axis positioner, an azimuthal rotator, a microwave vector network analyzer (VNA), a fixed receiving antenna, and a controlling computer. The AUT and the two-axis positioner are fixed on the azimuthal rotator, so that the axis of rotation of the AUT can be move to an arbitrary position. The *z*-axis (propagation direction) positioner, the rotator, and the VNA are automatically controlled by the computer via GP-IB. Let D be the maximum aperture size of antennas and λ the wavelength. The distance of the two antennas must be greater than $4D^2/\lambda$, where the near-field effect is negligible.

The AUT was automatically scanned on the z-axis, and the phase deviation due to the rotation of the AUT was automatically minimized using a binary search algorithm to determine the phase centers. The phase center at the single frequency of 8.44 GHz was obtained within 0.03 λ ($\cong$ 0.1 mm) by 6 reiterations. The automatization may eliminate human errors and reduce the time taken for measurements. The phase centers of an X-band pyramidal horns were measured with the proposed system and found to migrate up to 18 mm from the open end. The average of phase centers in E- and H-planes were in good agreement with calculation results using a full-wave 3D electromagnetic simulator.