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Power density estimation using back-projection technique for compliance assessment of wireless communication technologies operating above 6 GHz

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Wireless communication systems using the 60 GHz band (called WiGig or IEEE802.11ad) are now commercially available, and the use of frequencies from 6 to 100 GHz is also anticipated in fifth-generation (5G) mobile and wireless communications technologies. Expansion of these technologies is expected to raise public concern about the health risk of electromagnetic field exposure. Therefore, techniques to assess the compliance of the devices using these technologies are required. Power density is used as a measure to protect humans from the exposure at the operating frequency bands of the devices in several international guidelines/standards. In the actual use of wireless communication technologies, wireless devices are used in close proximity to the human body. Therefore, an assessment of the power density of the devices at short distances is required.

The power density in the proximity of an antenna is derived from the real part of the complex Poynting vector. This implies that both electric and magnetic fields are necessary to derive the power density. Due to the electrical coupling between the device under test (DUT) and the measuring probe, it is not easy to obtain these values by measurement in close proximity. We focused on a reconstruction technique called back-projection to resolve the problem. The technique can obtain electric and magnetic fields in the proximity of the DUT from the measurement of the electric field at a plane some wavelengths away from the DUT antenna. This technique simplifies the measurement process of the power density. However, the accuracy of the back-projection technique has not been well investigated.

This study aim to clarify the accuracy of the back-projection technique for the compliance assessment of devices operating at several frequencies from 15 to 100 GHz. To do this, the applicability of the technique was firstly assessed by comparing the maximum values of the spatially averaged power density back-projected from measurements and those obtained by computational simulation. Here, the comparison was conducted using a standard horn antenna at 60 GHz. Secondly, systematic errors of the back-projection technique were assessed for several planner array antennas at frequencies ranging from 15 to 100 GHz by computational simulation. Finally, the back-projection error relative to the measurement accuracy of the electric-field amplitude was estimated by computational simulation considering an actual measurement scenario. The results obtained here may support the standardization of procedure for compliance assessment for wireless devices operating above 6 GHz, which are expected to become increasingly common in the near future.

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