[PIERS 2013 Stockholm Abstract]

Optimal Size of Waterproofed Shielded Loop Antenna in a Tissue-Equivalent Liquid to Calibrate SAR Probe in HF Band

Nozomu Ishii #1, Ryosuke Takezawa #1, Hidenori Toyoshima #1,
Lira Hamada #2 and Soichi Watanabe #2
#1 Graduate School of Science and Technology, Niigata University, Japan
#2 National Institute of Information and Communications Technology, Japan

Recently, the wireless power transmission (WPT) technology in the HF band has been getting a lot of attention. One issue should be considered to realize the WPT technology is to ensure its safety in view of electromagnetic exposure. There are some exposure guidelines for the electromagnetic fields in the HF band, for example, setting exposure limits for electric field, magnetic field and specific absorption rate (SAR). We focus on the SAR to evaluate the exposure of the electromagnetic fields to the human body. SAR has been employed for the compliance test to the radio radiation protection guidelines of mobile communication devices from 30 MHz to 6 GHz. In our study, the probe calibration for standard SAR measurement based on extended Friis transmission formula in the GHz band can be expanded to the HF band. For the mobile communication devices, the electric-field type probes are used to detect the electric field intensity in the tissue-equivalent liquid of the standard SAR measurement system to obtain SAR, because the electric field intensity is superior to the magnetic field intensity. However, in the HF band, the electric field intensity is inferior to the magnetic field intensity so that the magnetic-field type reference antenna or loop antenna can be a strong candidate. In this paper, a waterproofed shielded loop antenna operated in the liquid will be examined. Our developed probe calibration or gain estimation in the liquid in the GHz band is to face the two identical antennas in the liquid and to estimate the far-field gain as the distance between them is changed. The wavelength in the HF band is much larger than the GHz band. For the physical limitation, it is impossible to assign the distance enough to satisfy the far-field criterion in the practical system so that the gain of the antenna in the HF band should be determined in the extremely near-field region. However, we present one solution to shorten the required minimum distance (about 0.1 wavelength in the liquid) by selecting the appropriate diameter of the loop antenna (0.638 wavelength in the liquid). This fact is ensured by the method of moments and experiment. It leads to the possibility that the gain of the waterproofed shielded loop antenna and SAR probe can be calibrated at a considerable short distance.