PROPOSAL OF ACCURATE SAR-PROBE CALIBRATION USING REFERENCE ANTENNAS IN THE LIQUID AT HIGHER FREQUENCY

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Abstract:

An accurate SAR-probe calibration is required for the mobile communication devices which are expected to be available above 3 GHz. The most popular method for the SAR-probe calibration below 3 GHz uses waveguides with matching dielectric spacer. An up-and-down movement of the SAR-probe in the liquid surrounded by the waveguide wall can obtain attenuation coefficient of the liquid which can determine the electric field in the liquid. At higher frequency, however, the size of the probe tip is comparable with the cross section of the waveguide. For example, the probe tip has about 2 mm diameter and the cross section has about 48 mm x 22 mm at 5.4/5.8 GHz. It can deteriorate the accuracy of the calibration.

The other method for the SAR-probe calibration uses a calibrated reference antenna and is based on the Friis transmission formula in the dissipated medium and 2 antenna method for determining the gain of the antenna. This method has an advantage that the reference antenna and the probe can be located in the water tank which is much larger than the waveguide. In this view point, we have studied this method as one candidate of the accurate SAR-probe calibration above 3 GHz. In this calibration, the transmission between two identical reference antennas is measured at fixed distance between the antennas. To improve the accuracy of the calibration, we have proposed that the transmission coefficients, consisting of magnitude and phase of S21, should be measured as a function of the distance. When two reference antennas are faced and S-parameters are measured by use of the vector network analyzer, we can determine the attenuation and phase constants of the liquid and the gain of reference antenna by curve fitting technique.

In this study, we test our proposed method by use of Richmond fs code for wire structure in the complex medium. From numerical simulation, the far-field criteria, which is required for applying to the Friis transmission formula, is not always satisfied in the measurement because a signal radiated from transmitted antenna may be less than the noise floor of the measurement system. That is, the reference antenna can not be calibrated in the far-field region, because of high attenuation of the liquid. For a half-wavelength dipole, this method is valid if the distance between dipoles is more than 1.5 wavelengths in the liquid. And the gain of the half-length dipole obtained by the Richmond fs code approach with the curve fitting technique when the distance is larger. This tendency is observed for half-wavelength dipole of 900, 1450, 1900, 2450 and 5400 MHz.

In our experiment, an open rectangular waveguide with matched dielectric and flange is used as a reference antenna, because the far-field distribution of the radiator can be obtained by the closed-formed mathematical expression once its amplitude is determined. The effect of the diffraction caused at the flange edge and the reflection caused at the feed connection can be ignored because of high absorption in the liquid.

In short, we propose a new procedure of the SAR-probe calibration based on the Friis transmission formula and curve fitting technique, and clarify its validity and limitation by the numerical simulation. Also, we describe a dielectric-filled open waveguide as a reference antenna. Now, we are planning the gain measurement of the above antenna using the new method of the SAR-probe calibration.