MOTOROLA SOLUTIONS

Validation of the numerical HAE6016A antenna model per IEC/IEEE 62704-2-2017 standard

The numerical antenna model validation was performed according to Clause 6.1 of the IEEE/IEC 62704-2-2017 standard. Accordingly, a 1070 mm diameter ground plane model was used with the antenna mounted in the center to calculate the electric and magnetic field values along a vertical line parallel to the antenna axis, at 20 cm separation distance from it.

A high resolution FEM (Finite Element Method) based simulation was conducted using CST Microwave Studio® (CST MWS) software to generate the reference field values at test points equally spaced along the vertical line, with 5 mm step up to a height of 400 mm above the ground plane, which is higher than the antenna tip (83.4 mm above the ground plane surface).

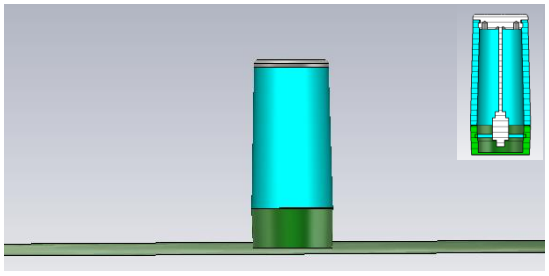
The physical antenna comprises a thicker base element, incorporating a spring-loaded RF-feed contact to the base connector on the ground plane, a straight center wire conductor surrounded by a plastic shroud and terminated at top with metal cap.

The reference antenna model was designed by taking accurate measurements of the antenna element physical dimensions as well as using the available CAD model of its housing and creating a model in CST MWS. The FEM simulations were performed with adaptive mesh refinement and the electric and magnetic near field values along the vertical line were computed. The convergence level for adaptive mesh refinement was set to 1e-2[1] for S-parameters at the antenna feeding port and 1e-4[2] for the

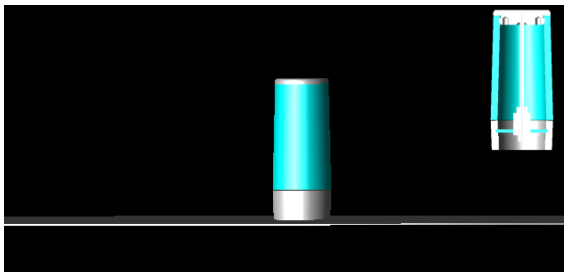
[1] The convergence criterion for S-parameters was defined as the maximum deviation of the absolute value of the complex difference of the S-parameters between two subsequent passes.
[2] The convergence criterion for field amplitudes computed along the line was defined as the their maximum deviation between two subsequent passes along that line.

amplitudes of the electric and magnetic field values computed along the line as described above. The same setup was simulated to compute the E and H field values using XFDTD code with the same maximum resolution of the FDTD grid that would be used in subsequent exposure compliance simulations as required by the IEEE/IEC 62704-2-2017 standard.

The figures below illustrate the CST MWS (FEM) and XFDTD antenna models.



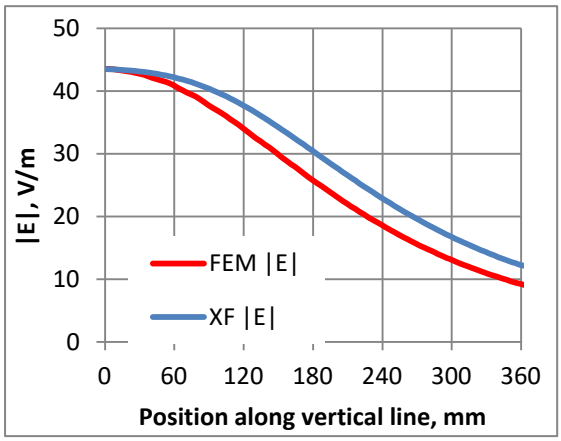
CST MWS (FEM) model of the HAE6016A antenna



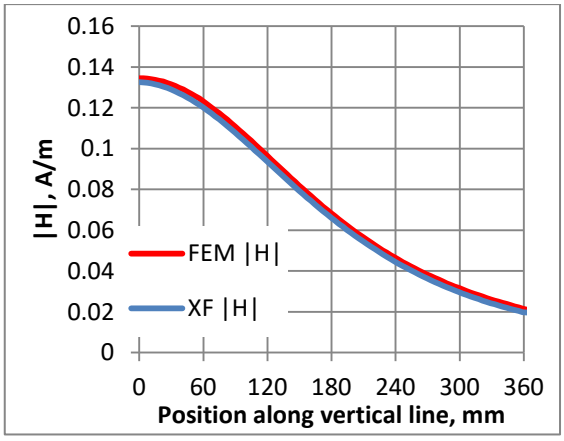
XFDTD model of the HAE6016A antenna

Finally, the amplitudes of the electric and magnetic field values computed at 480 MHz with XFDTD were compared to the reference values from high resolution CST FEM model and the deviation was evaluated according to equation (7) of the IEEE/IEC 62704-2 standard to quantify the uncertainty contribution of the numerical antenna model, resulting in **14.9% uncertainty**.

The plots below illustrate the magnitudes of electric and magnetic fields along the vertical line, at 20 cm from the antenna axis, computed using CST MWS (FEM) and XFDTD codes, and normalized to 0.5W net average input power at 480 MHz.



Electric field magnitude



Magnetic field magnitude