MOTOROLA SOLUTIONS

Validation of the numerical RAE4016ARB 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.

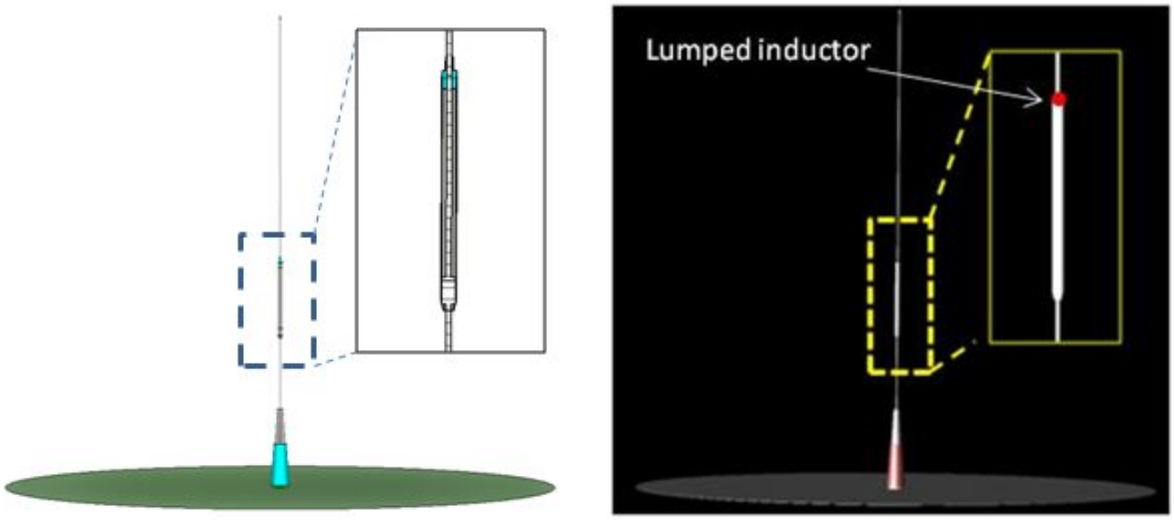
The physical antenna comprises a thicker base element, incorporating a spring-loaded RF-feed contact to the base connector on the ground plane, the spring feed connects to helical coil attached to large spring base with a first wire element and ends with a second wire element with a quarter wave choke in the middle. The antenna operating frequency range is 494-512 MHz and for a specific actual operating frequency the length is trimmable to provide optimal tuning and matching condition. Three trimmed versions were evaluated corresponding to 495 MHz, 503 MHz, and 512 MHz.

A high resolution FIT (Finite Integration Technique) 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 10 mm step up to a height of 962 mm above the ground plane, which is higher than the antenna tip (857 mm length at 495 MHz operating frequency). The reference antenna model was designed by taking accurate measurements of the antenna element physical dimensions as well as using the detailed CAD model and creating a model in CST MWS. The accuracy of the high resolution reference model was verified by comparing the simulated return loss and the far field pattern with measured results.

The FIT simulations were performed with Time Domain Parameters and the electric and magnetic near field values along the vertical line were computed. The convergence level for mesh refinement was set

to 1e-2[1] for S-parameters at the antenna feeding port and 1e-4[2] for the 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 model. In this model the choke based reactive load in the mid section of the antenna was replaced by a solid metal part of the same shape as choke and a lumped Inductor featuring the choke equivalent inductance as shown in the figure below. The XFDTD model was simulated with the same maximum resolution of the FDTD grid as 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 (FIT) and XFDTD antenna models.

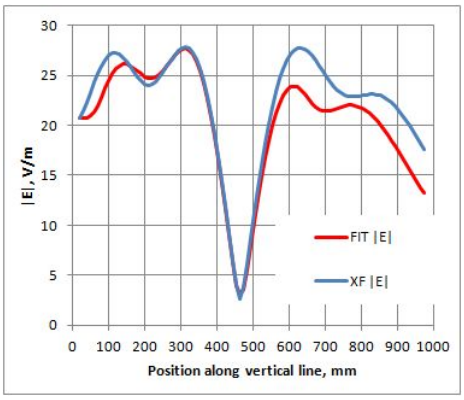


CST MWS model **XFDTD model**

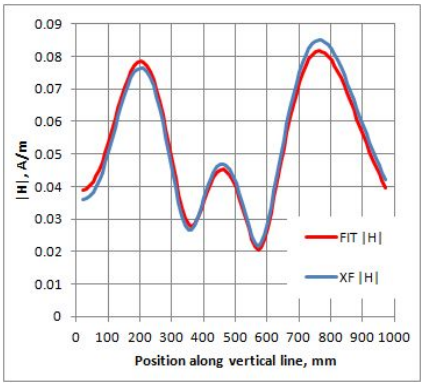
Finally, the amplitudes of the electric and magnetic field values computed at 495/503/512 MHz in XFDTD were compared to the corresponding reference values from high resolution CST FIT model and the deviation was evaluated according to equation (7) of the IEEE/IEC 62704-2:2017 standard resulting in 30.5% at 495 MHz, 22.2% at 503 MHz, and 27.6% at 512 MHz uncertainty. The worst case of 30.5% was used as the uncertainty of this numerical antenna model within all applicable frequency range of this antenna.

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 (FIT) and XFDTD codes and normalized to 0.5W net average input power at 495/503/512 MHz.

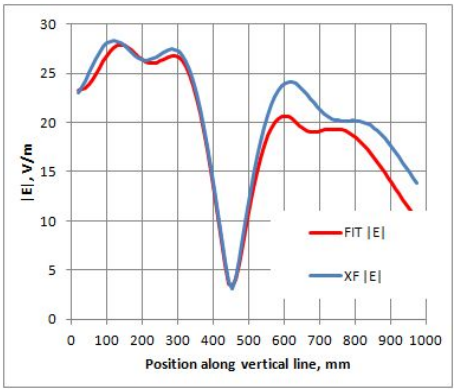
[1] **The convergence criterion for S-parameters was defined as the maximum deviation of the absolute value of the complex difference of the S-parameters between two subsequent passes.**
[2] **The convergence criterion for field amplitudes computed along the line was defined as the their maximum deviation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



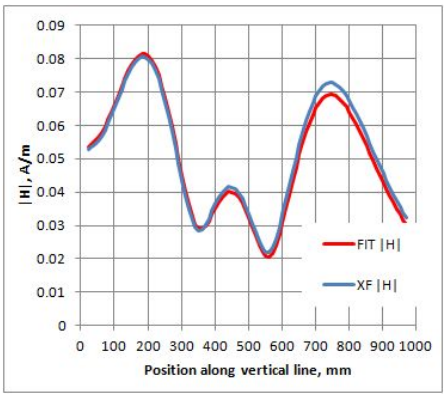
Electric field magnitude (495MHz)



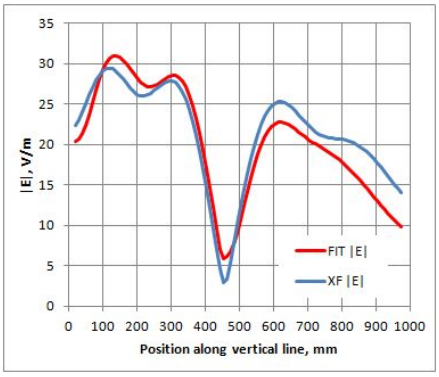
Magnetic field magnitude (495MHz)



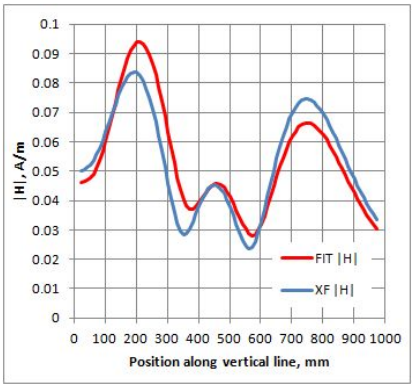
Electric field magnitude (503MHz)



Magnetic field magnitude (503MHz)



Electric field magnitude (512MHz)



Magnetic field magnitude (512MHz)