SMART ENTRY SYSTEMS SIMULATION

Introduction

Smart Entry System is one of most popular safety systems. Smart Entry allows driver to open the door and activate some electrical systems while being outside the vehicle. Also Smart Entry System allows driver to be identified by the car electronics and start the engine without mechanical key.

System consists of several antennas transmitting signals one to another: antennas fixed on the car body and antenna in the driver 'remote key'. Parts of antennas are oriented to out-vehicle zone, and another part is oriented to the operation inside vehicle. Operation of the system is usually realized on two defined frequencies: low frequency 125 kHz for radiating mode, radio frequency (433 MHz or 315 MHz) for receiving mode. For the low frequency coil antenna wounded around ferrite is used. This antenna does not provide high-radiated power due to low efficiency. Thus determination of areas where radiated field level outside car is enough to be recognized by receiver is very important. Vice versa, areas inside car where field level is too low should be eliminated.
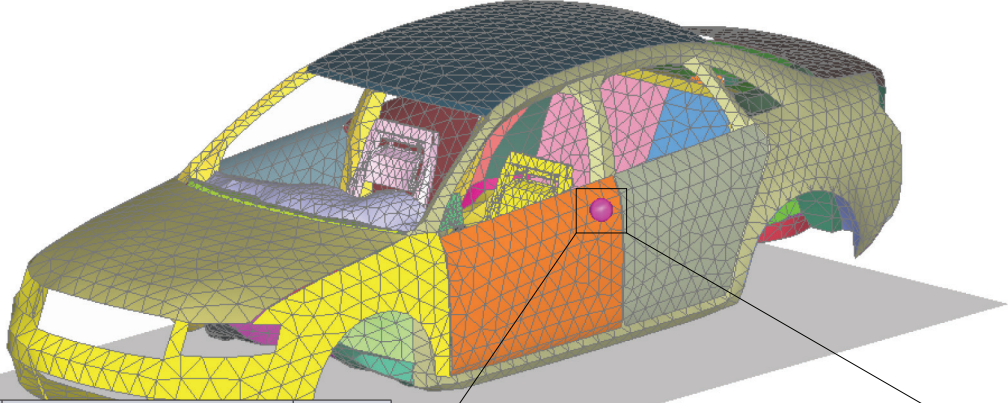
This application demonstrates modeling of Smart Entry System and radiated field analysis within EMC Studio / EMCoS Antenna VLab environment.
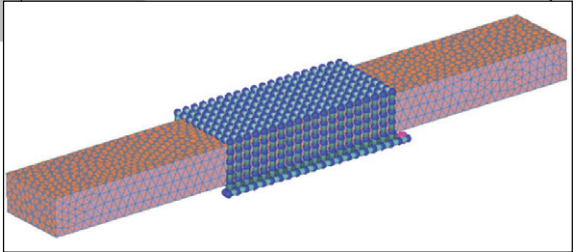
Simulation Model Description

We consider modeling of antennas oriented to field radiation outside the car. In this case one of the typical antenna locations are front door handles. Calculations are performed for 20-turn coil antenna wounded around rectangular ferrite rod.
Calculations of magnetic field at frequency 125 kHz in the plane surrounding car model are performed. Extension of near field area outside the car is 1.5 m from all sides. Grid step used for calculation is 10 cm.

Two Ferrite Rod Antennas Placed in the Front Doors of the Vehicle

Ferrite Antenna Model

|	Parameter	Value
Coil Antenna	Wire radius, [mm]	0.1
	Voltage source amplitude, [V]	10
	Operating frequency, [kHz]	125
Ferrite Rod	Length, [mm]	60
	Width, [mm]	8
	Height, [mm]	4
	Relative permeability	1000

For simulation of antenna near the car body two variants are used:
- Only antenna in driver door is activated
- Both antennas are activated

Only Antenna in Driver Door is Activated
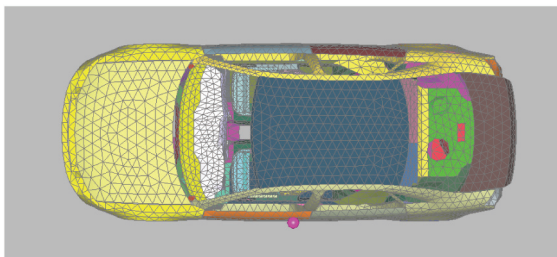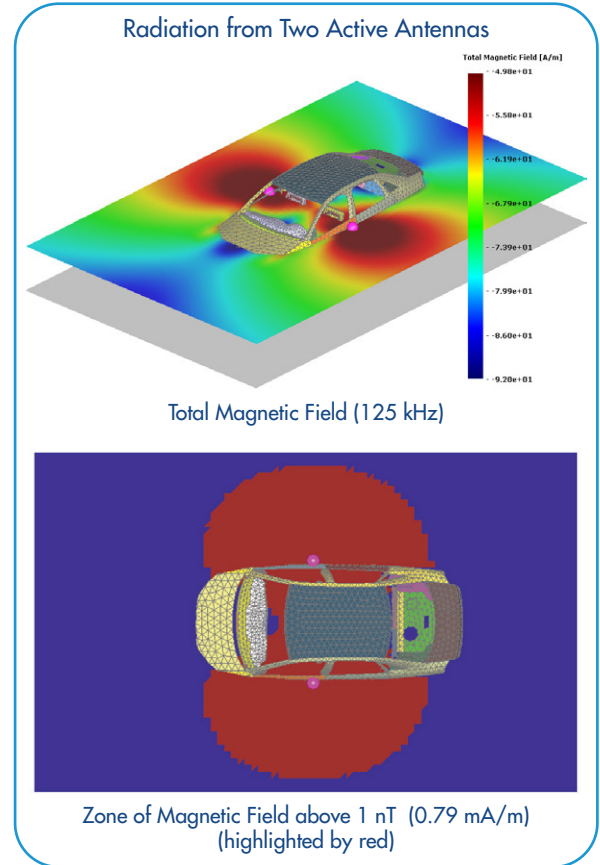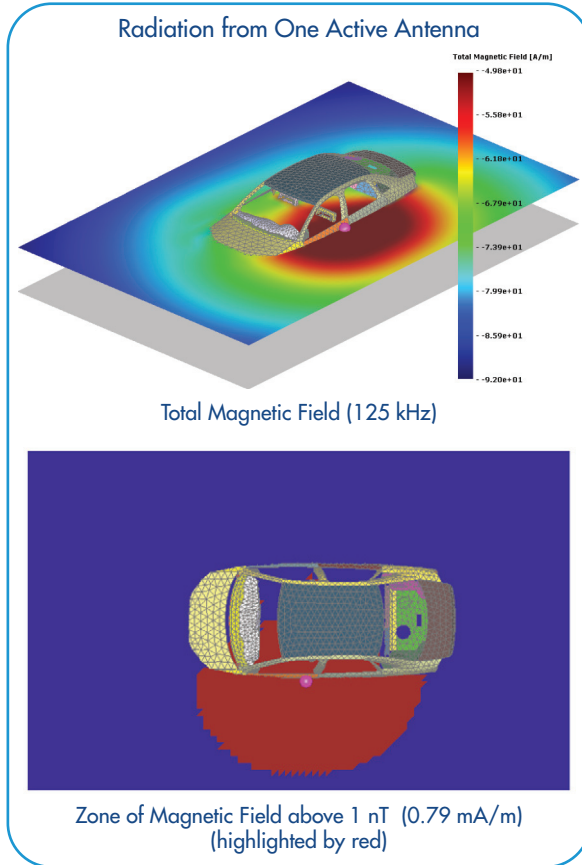

Both Antennas are Activated
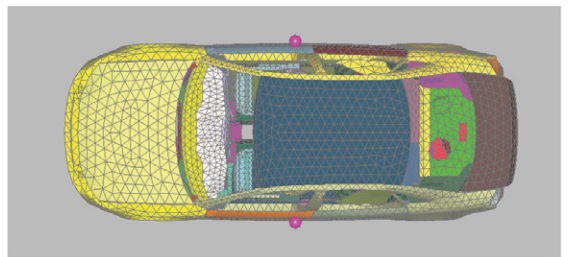
EMC Studio/EMCoS Antenna VLab Application Note: #11

Results

For analysis of radiated field level special option in EMC Studio / EMCoS Antenna VLab environment is used.

Typical sensitivity of receiving antenna is about 1 nT, what corresponds to H=0.79 mA/m. Defining this level in the dialog for Near Field Post-processing we obtain complete near field area colored in red and blue (red color corresponds to area above or below defined reference value, depending on selected option). Magnetic field distribution and areas characterized with magnetic field level above the receiver sensitivity limit for both simulation cases are shown below:

Radiation from One Active Antenna

Total Magnetic Field (125 kHz)

Zone of Magnetic Field above 1 nT (0.79 mA/m)
(highlighted by red)

Radiation from Two Active Antennas

Total Magnetic Field (125 kHz)

Zone of Magnetic Field above 1 nT (0.79 mA/m)
(highlighted by red)

Special post processing tool provides advanced visualization options for convenient analysis of smart entry antenna systems – Iso-line and Iso-surface view modes. Iso-surface field reference visualization options is available for near fields calculated in volume near field grid

Radiation from Two Active Antennas Iso-surface View

Conclusions

According to performed investigation the main conclusions are:

- Simulations of low frequency coil antennas with ferrite rod, used for Smart Entry System, can be effectively done in EMC Studio / EMCoS Antenna VLab environment
- Convenient analysis of radiated field can be performed using special post-processing option

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