Application Sheet

FEKO

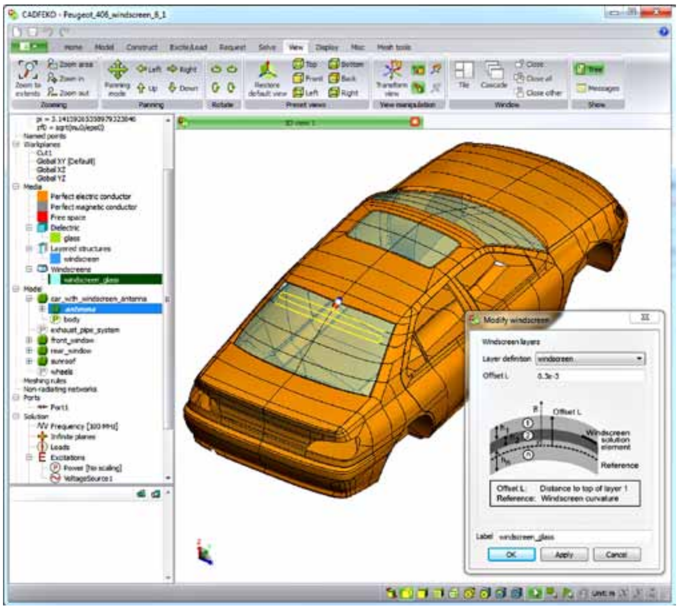
Comprehensive Electromagnetic Solutions

Integrated Windscreen Antenna Analysis

Introduction

The growing trend in the automotive industry is to include a wide variety of antennas in vehicles. Antennas for AM and FM radio, television, GPS navigation, GSM communication and automated tolling are becoming standard on vehicles. To find a combination of antenna topologies and locations that is both functional and aesthetically acceptable, is a challenging task. The integration of antennas into windscreens has become a popular solution.

However, the design of such antennas is a complex procedure, requiring the ability to analyse electromagnetic interactions between thinly layered dielectrics, thin embedded wires and the surrounding vehicle body. FEKO provides accurate and efficient solutions to analyse complex integrated windscreen antennas.



Windscreen antenna analysis setup

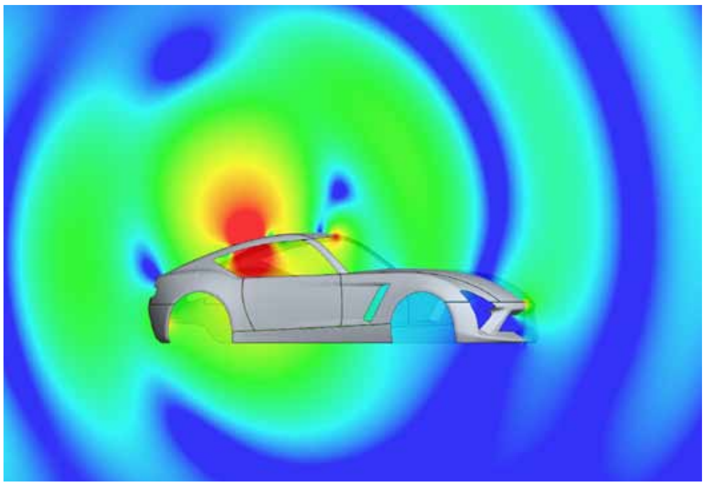
Solver Features

The dedicated windscreen antenna analysis feature of FEKO allows the user to analyse the electromagnetic behaviour of integrated windscreen antennas within their operating environment. The analysis can take into account the physical features of windscreen antennas and their surroundings, including:

- Finite sized windscreens
- Arbitrarily curved windscreens
- Multiple dielectric windscreen layers (glass, plastic, and other dieletric materials)
- Mutual coupling between antenna elements
- Multiple windscreens in a vehicle (multiple glass definitions supported)
- The vehicle body
- The presence of a real ground

The analysis is based on the method of moments (MoM) and can be used in conjunction with the multilevel fast multipole method (MLFMM). It is an efficient approach due to only including the vehicle body and metallic antenna elements in the MoM mesh. Numerous electromagnetic characteristics of the windscreen antenna can be computed, including:

- Current distribution on the antenna and vehicle
- Input impedance bandwidth and scattering parameters
- Near field distributions and far field radiation patterns

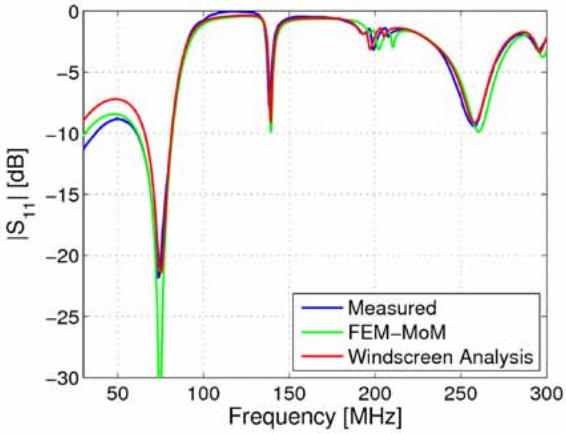


Visualisation of near fields

Apart from the dedicated windscreen antenna analysis feature, FEKO also supports the inclusion of dielectric coated wires in its models. Using this alternative technique, the windscreen antenna wires can be modelled by assigning coating properties to the wires to represent the effect of the windscreen dielectric sheet. This approach breaks down for closely spaced wires where the mutual coupling effects are high.

Validation Example

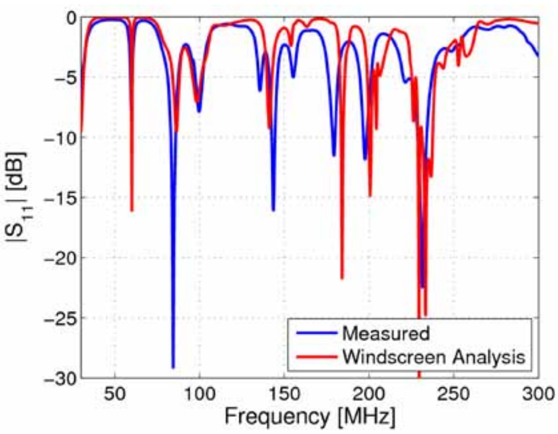
Consider a flat, rectangular, framed glass panel with integrated antenna, above a finite ground plane. The glass is 3 mm thick, with tan(δ) = 0.02 and ε_r = 7. The response of this antenna was simulated with the rigorous FEM / MoM approach as well as with the efficient windscreen analysis approach, and the results compared with a measurement. The FEM / MoM required 1.79 GBytes of memory, while the windscreen analysis method required only 280 MBytes and had dramatically reduced runtime. These results show that the windscreen analysis approach is accurate as well as computationally efficient.

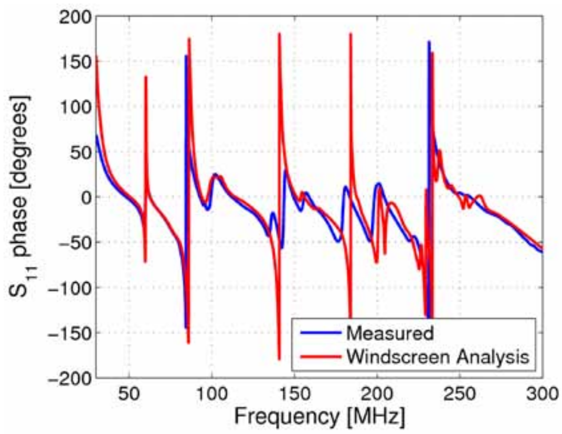


Comparison of reflection coefficient results of an antenna integrated in a framed glass panel

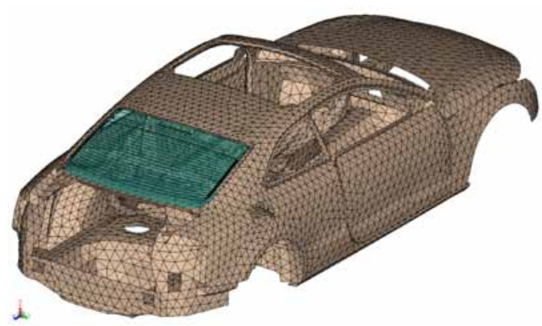
Automotive Example

Now consider a complex antenna integrated into the rear window of a car. The glass is 3.15 mm thick, with tan(δ) = 0.01 and ε_r = 6.85. The antenna wire radius is 0.3 mm. The window is curved and the antenna consists of wire sections that couple strongly to one another, as well to the vehicle body. The windscreen analysis results again show excellent agreement with measured results, especially when considering the complexity of this model.

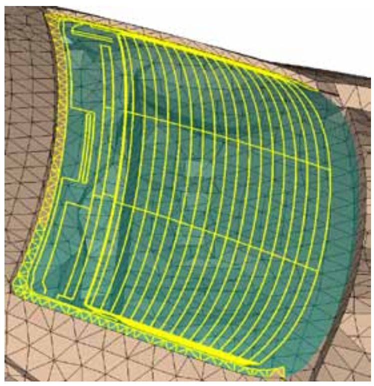




The magnitude (top) and phase (bottom) for the simulated rear windscreen antenna versus measured data



FEKO model of a vehicle with integrated rear windscreen antenna



Detailed view of rear window with highlighted antenna

Altair

32 Techno Ave, Technopark, Stellenbosch, South Africa
Phone: 0027 21 831 1500 • Fax: 0027 21 880 1936
www.altair.com • info@altair.com