Comprehensive Electromagnetic Solutions

FEKO

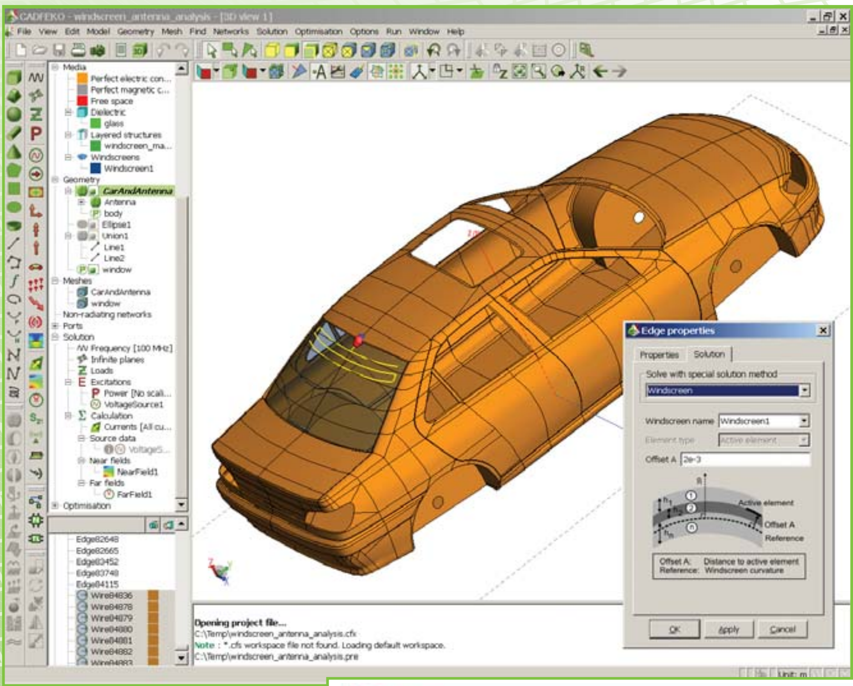
Integrated Windscreen Antenna Analysis

Introduction

Vehicle manufacturers are incorporating an increasingly wide variety of antennas into vehicles for AM, FM, television and GPS reception, for GSM communication, for automated tolling, and so forth. To find a combination of antenna topologies and locations, which is both functional and aesthetically acceptable, is a very challenging task. 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.

Solver features

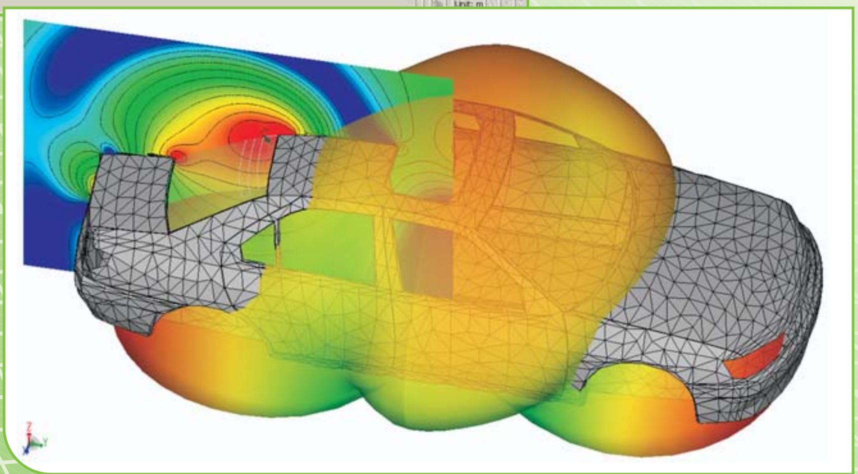
The dedicated windscreen antenna analysis feature of FEKO allows the user to analyse the electromagnetic behaviour of integrated windscreen antennas within their operating environment. The analysis can take all physical features of windscreen antennas and their surroundings into account, including:



- Finite sized windscreens
- Arbitrarily curved windscreens
- Multiple dielectric windscreen layers (glass, plastic, etc.)
- Mutual coupling between antenna elements
- Multiple windscreens in a vehicle
- The vehicle body
- The presence of a real ground

The analysis is based on the method of moments (MoM). Only the vehicle body and metallic windscreen antenna elements are included in the MoM mesh, which makes the analysis very efficient. Various electromagnetic characteristics of the windscreen antenna can be computed, including:

Left: Windscreen antenna analysis setup
Below: Visualisation of near and far fields



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

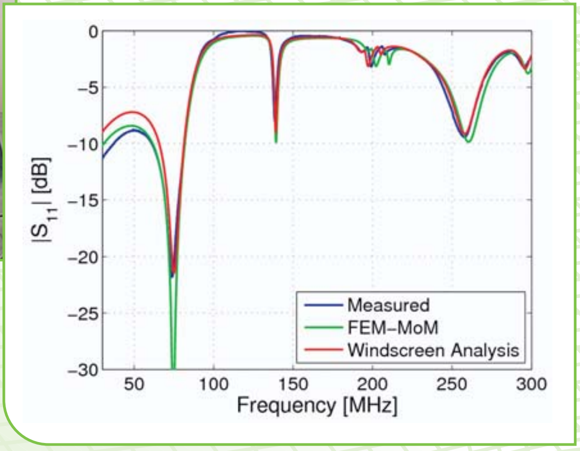
Apart from the dedicated windscreen antenna analysis feature, FEKO also supports the inclusion of dielectrically coated wires in its models. This feature can alternatively be used to model windscreen antenna wires by assigning coating properties to represent the effect of the windscreen dielectric sheet, but the approach breaks down for closely spaced wires where mutual coupling effects are strong.

FEKO is a product of EM Software & Systems-SA (Pty) Ltd

Validation example: measurement setup

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, with dramatically reduced run time. These results show that the windscreen analysis approach is very accurate as well as computationally very efficient.

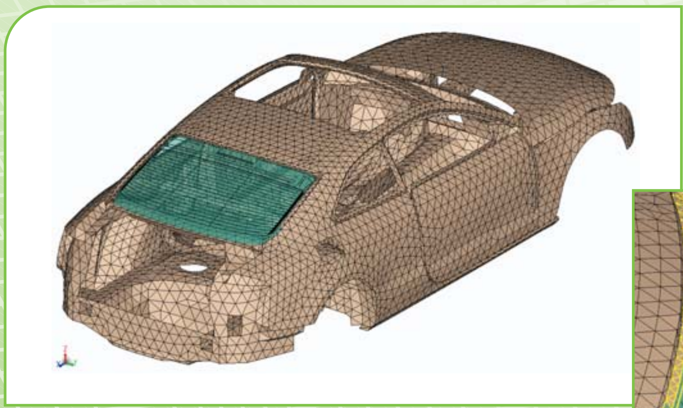


Validation example: comparison of reflection coefficient results

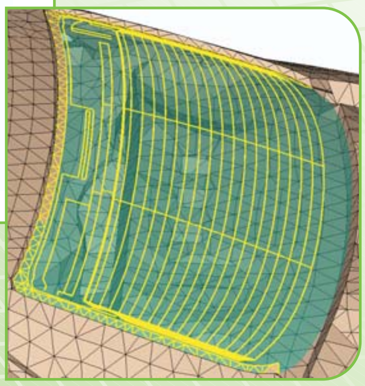
Automotive example

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.

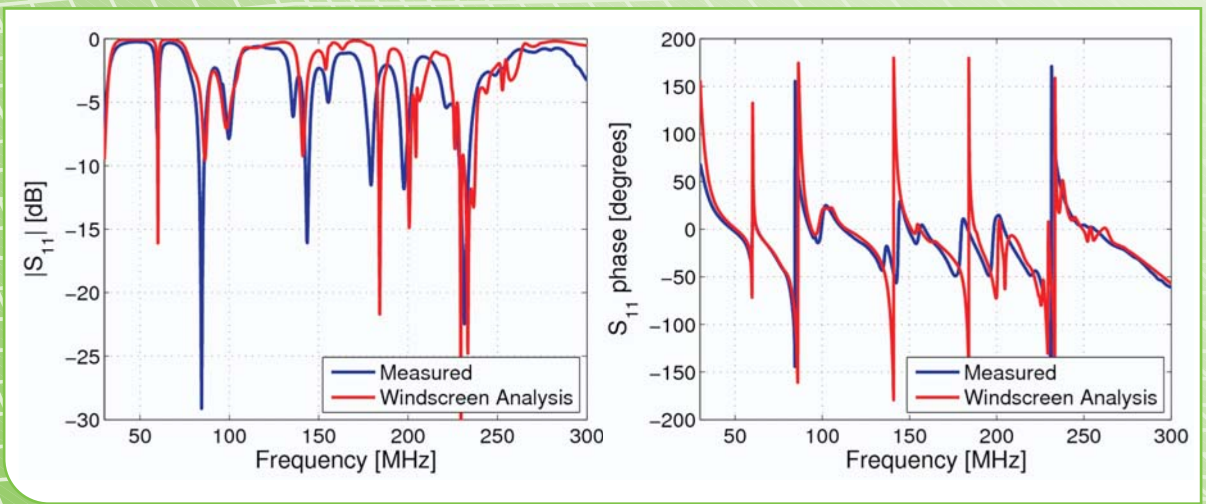
As can be seen, the window is generally curved and the antenna consists of wire sections which will couple strongly with each other, as well as with the vehicle body. The windscreen analysis based reflection coefficient results again show excellent agreement with measured results, especially considering the complexity of this model.



Automotive example: FEKO model of a car with integrated windscreen antenna



Automotive example: detail view of the car rear window with highlighted antenna



Automotive example: simulated vs. measured magnitude and phase of the antenna reflection coefficient

www.feko.info