EM-Twin Automotive Tutorial Antenna placement on the Roof of a Car



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3D CAD model import Antenna digital twin creation

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Overview

• Field source placement & alignment

Using the automotive Wizard

- Simulation set-up
- Car model set-up (material definition)

New project creation

- Simulation
- Near- & Farfield evaluation

Audi car with antenna digital twin on roof







Start

- Start EM-Twin
- Select "New Project"
- Press OK
- Press Save as & create a storage folder and enter file name, e.g., "RoofAntenna_Car"
- Press Save

			iempiac					
General			Getting Started		Application Notes			
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Frequency			EMPIRE	Open the Full Manual	🚾 Import layout data into Empire XPU			
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Wizard step 1: CAD Import



- Under 3D Design > General, click on the icon "EM Twin Wizard"
- The first step is to import the CAD geometry of the complete vehicle
- Click on 'CAD Import' and locate the Collada file "72175 Audi RS4 Avant 2013.dae"
- Click Close once the import is finished and continue with Next





Wizard step 2: Material assignment

 Open Group list of imported Audi CAD by click on arrow



Info

- Double click on physical Property of Audi groups and change to Steel:
 - Select Database -
 - Select Steel-1010
 - Press OK

 Conductivity (A/V/m) Thermal Conductivity User Date Name Alloy Absorber Aluminum Advanced Copper - Advanced Material General Debye Material Metal - Drude/Plasma Material Steel – Meta Material Cast-Iron 1.500e+06 55.0 Gabriel Material Iron-Element 1.030e+07 80.4 - Conformal Dielectric - Steel-1008 7.6900e+06 59.5 Metal Sheet Stack ⊢ Steel-1010 6.9930e+06 Material Scripts └─ Steel-Stainless 16.0 1.100e+06 Material Script ▶ VAC Drude/Plasma Script Water Circuit Property

General

Database

The Physical property of the top group is inherited to all Sub-groups. This property is changed from ideal conducting metal (default) to steel.

Material Property

Dielectric



Wizard step 3: Material assignment

Hovering with the mouse pointer over different groups highlights the corresponding objects in the preview window

erty Editor - Dielectri

- Move the mouse to the group '8080807f' (grey color); the corresponding objects are marked in green (glass windows, lamp,..)
- Double click on the group name and change name from '8080807f' to 'Glass'
- Right click on the name and choose 'Edit property'
 - Select Dielectric
 - Select Database
 - Select 'Common'
 - Select 'Cornig Glass'
 - Press OK
- Press next and confirm changed group settings



Dielectric	Name	 Permittivity 	Loss Tangent, tan(δ)	Thermal Conductivity	User Database
Conductor Absorber	Arlon Common				
 Advanced Advanced Advanced Material Debye Material Drude/Plasma Material Gabriel Material Gabriel Material Conformal Dielectric Metal Sheet Stack Material Script Drude/Plasma Script Circuit Property Mesh Property Mesh Property Mesh Property Material Circuit Circ	- Air Alumina Alumina-(99.5%) Alumina-92-pct Alumina-96-pct Aluminium-Nitride-AlN Bakelite	1.00058986 9.4 9.90000 9.2 9.4 8.8 4.80000	0 4.00E-04 1.00000e-04 8.00E-03 6.00E-03 3.00E-04 0.00000e+00	0.026 30 30 20.0 24.7 285	
	- Beryllia - Bone - Brain - CEM-1 - CEM-3 - Corning-Glass - Diamond - rod	6.5 12.66100 38.11100 4.40000 3.90000 5.75 5.68000	4.00E-04 0.00000e+00 0.00000e+00 3.00000e-02 2.50000e-02 4.70E-03 0.00000e+00 2.550.02	1.22	





Wizard step 4: Create & place source

- Select option Convert R+S Format
- Locate folder "R_S_Source_data" and left-click on folder name (CarFin_1deg)
- Choose 1800 MHz as import frequency

The frequency must be selected if an antenna has been measured at several frequency points and if the corresponding nearfield currents have been created

 Click Close once the import is finished

This way, the source file for the antenna digital twin "1_8GHz.surf.dat" is created in the project folder. The 3D radiation pattern of the source is shown in the Wizard

 Click on Place and Setup Antenna Field Source



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Wizard step 5: Field source placement

- Click on Iso-Z view; the imported 3D CAD model of the car appears on screen
- Zoom in to the rooftop of the vehicle
- Left click on a point along the central axis of the vehicle, close to the dummy shark-fin object





Wizard step 6: Field source placement

The antenna was measured in the chamber with an alignment where phi=0 (x-direction) was aligned with the forward facing sharkfin antenna module (see picture below)





Within the digital antenna twin field source placement, the udirection corresponds to the x-direction in the measurement (v corresponds to y and w to z).

As the sharkfin module should also be facing forward when using the antenna digital twin source, the u-direction must face forward. The upper right picture shows the u-direction pointing the left side of the car, so this can be achieved by a rotation around w axis.





Wizard step 7: Field source placement

- Select 'Rotate Antenna Field Source'
- Keep w as rotation axis
- Enter a rotation angle so that u is pointing to front of car,
- Press OK

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The antenna digital twin field source is now correctly placed on the roof of the





- Select 'Configure Antenna Field Source'
- Choose General -> Disable Sides: zmin
- Press OK

The zmin side of the field source must be disabled as the antenna was measured on a large metal ground plane



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Wizard step 8: Structure rotation for simulation, Delete Shark fin mokup



Radiating field sources are box-shaped objects that need to be properly aligned with the Cartesian coordinate systems. This is currently not the case as the field source is aligned with the curved roof from the car

- Click on 'Rotate Structure and Antenna Field Source for Simulation'
- The Field source is now properly aligned with the car and the mesh for simulation
- Click Next







Wizard step 9: Simulation set-up

- The mesh setting has an influence ٠ ono the accuracy of the results
- Option Coarse (10/3) is a good • starting point for initial investigations
- Depending on the user's available computing power, finer meshes can be selected later
- Click Finish to terminate the Wizard and return to 3D Design
- Select the Shark Fin mockup ٠ with a left click
- **Press Delete**



M Setup		
Structure Type	Antenna Field Source	
Target Frequency	1.8	
leshing		
Mesh Resolution	Coarse (10/3)	
Mode		
All Conductors Meshing Setup	Bounding Box only	
All Dielectrics Meshing Setup	IIII off	
oss Calculation		
Dielectrics	narrow band (target-freq)	
Conductors	narrow band lossy	
ield Monitors		

< Back Finish Cancel



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Wizard step 10: Model discretization



- Click on Create Mesh to discretize the model
- The 10/3 setting leads to hexahedral cells roughly 14 mm in size
- Model complexity is approx. 7 Mcells
- Switch to 2D Design mode and Select Front view
- Notice how the car model is tilted downwards after the rotation that levelled the field box





Step 11: Simulation

- 1. Press Icon Start Simulation
- 2. Press OK

2D Design	3D Design	Simula	tion	2D R	sults	3D Results						
	Simulation											
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Simulation log output at startup

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<u>File Edit View Selection</u>	<u>U</u> tilities <u>H</u> elp)					
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Energy convergence shown during simulation

Simulation stopped after 30 dB energy decay reached, postprocessing started

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3D Results: Far-field pattern

- 1. Switch to 3D Results
- 2. Open Field Monitors





I M S

3D Results: Near-field distribution

- 1. Turn off EM Farfield
- 2. Turn on Field Monitor 2



Antenna digital twin vs. full antenna simulation



Full antenna simulation



Antenna measurement



Antenna digital twin simulation







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Antenna digital twin vs. full antenna simulation



3D Farfield pattern



Full antenna simulation: Directivity 6.4 dBi

Antenna digital twin: Directivity 6.67 dBi



Antenna digital twin vs. full antenna simulation



Near Field Distribution



Full antenna simulation

Antenna digital twin

The antenna digital twin model achieves an excellent agreement with the full simulation model in less than 2 min simulation time



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