RFID Transponder operating at 13.56 MHz

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Radio Frequency Identification Systems (RF-ID) are widely used and allow advanced solutions for a variety of applications in the area of authentication, ticketing, access control, supply management, etc. The example presented here is operating at 13.56 MHz with dimensions given by an Internet data sheet. After rebuilding the 3D geometrical model the frequency domain solver of CST MICROWAVE STUDIO® has been used to accurately compute the input impedance versus a limited frequency band. In another step the impedance data has been used as a reference to develope a simple equivalent circuit consisting of lumped elements.

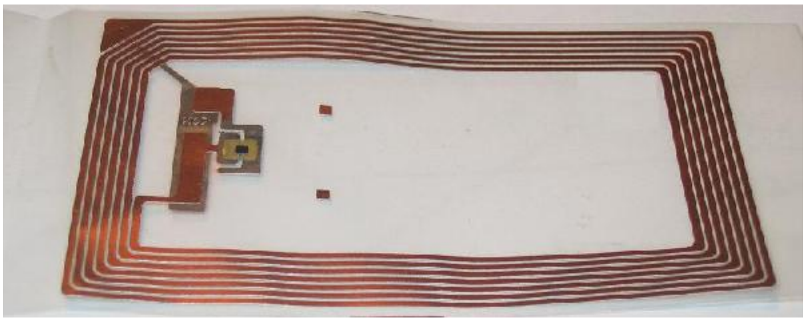

Figure 1: Photo of the transponder

Figure 1. shows a typical example of an RFID. Dimensions are publically available, e.g. on the Internet. The 2D-layout was modeled in CST MWS. Applying appropriate extrusion operations to create metal thicknesses and by adding the substrate (with an assumed epsilon-rel=3) the model was converted into a 3D model shown in Figure 2.

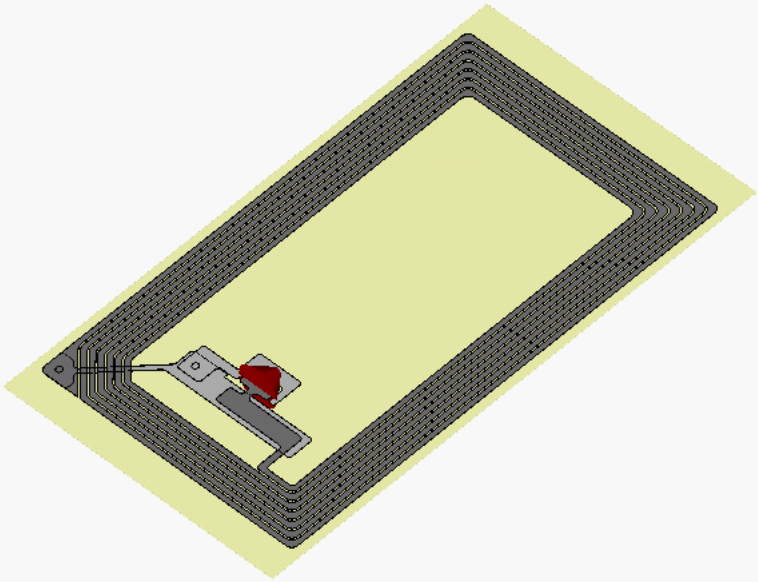

Figure 2: 3D- Model of the RF-ID tag used for simulation

The frequency domain solver was applied to calculate the S-Parameter as the primary result, shown as Smith-Chart representation in Figure 3. The mesh consisted of approximately 300.000 Hexa-meshcells with a runtime of 20 min per frequency point (2.6 GHz PC); 5 frequency points gave the required accuracy for the broadband result covering the range of 10-15 MHz.

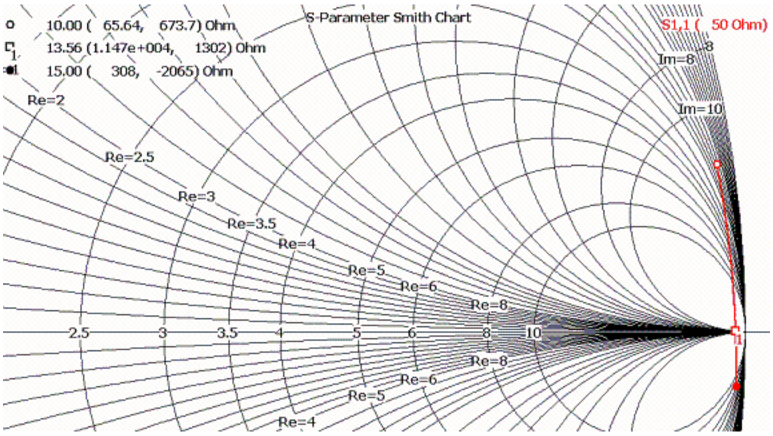

Figure 3: Smith Chart Representation of the reflection parameter S11

The reflection coefficient can be used to be converted into an impedance curve which is more convenient for illustration purposes. The result of this conversion is shown in Figure 4: The real part of the impedance shows its maximum at the resonance of about 13.56 MHz, whereas the the reactance passes a zero crossing. The behaviour of the impedance curve is very much similar to a parallel LC resonance circuit with a small damping included. Thus a simple RLC parallel resonance circuit was used as equivalent circuit and the three lumped element values of R, L and C where found by a curve-fit optimization of the reflection coefficient S11 within CST DS. Impedance curves are shown for both, the 3D model and the equivalent circuit model in Figure 4. The Q-factor of the equivalent circuit is computed by the equation Q= 1/(1/R*sqrt(L/C)) = 25.9.

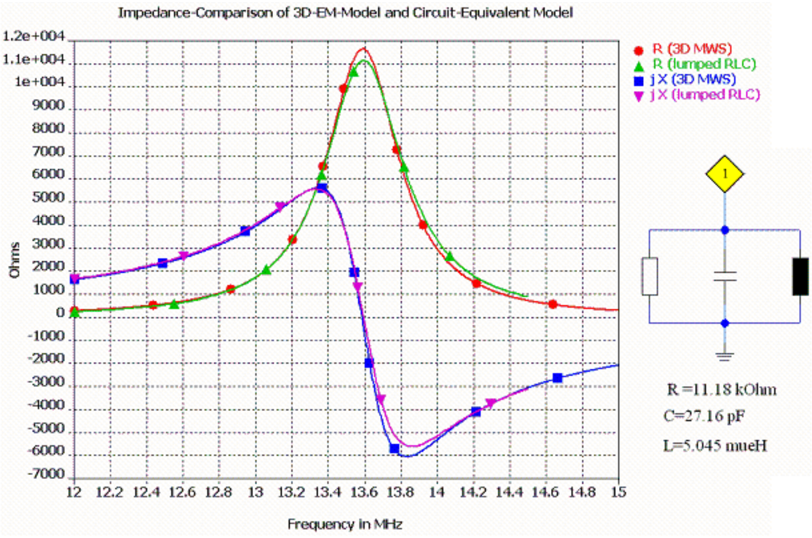

Figure 4: Impedance R+jX of the 3D model and the equivalent circuit model. For small band comparison the results agree very well

Not only integral parameters can be computed in CST MWS but also near fields of the calculation domain. Current distributions and magnetic field radiations can be observed and quantified.

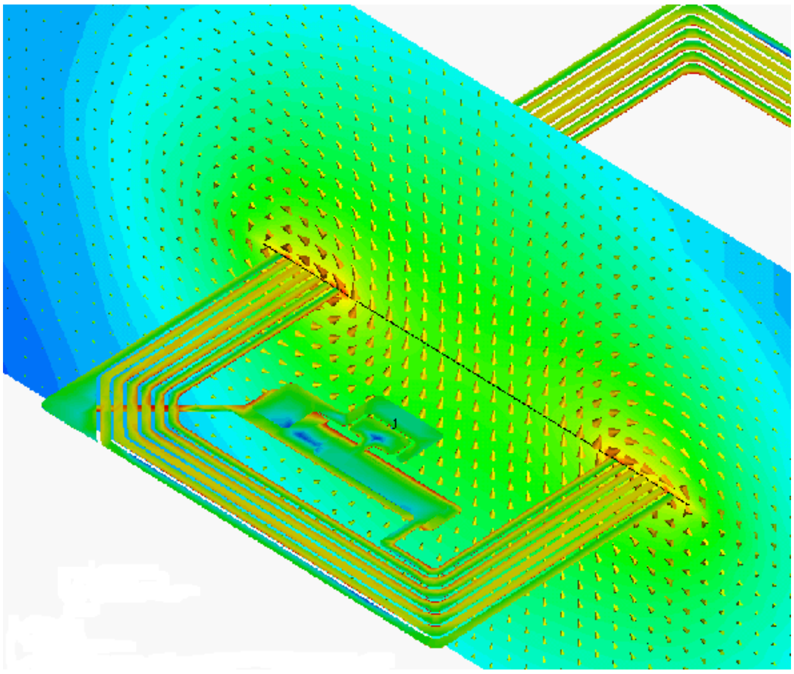

Figure 5: Depicted here is the surface current distribution of the coil and the magn fieldstrength along a vertical cutplane at 13.56 MHz

Conclusion:

The application example of an RF-ID demonstrates the ability of CST MWS to simulate antenna structures in a low frequency band helping to understand and describe the characteristics of the device without heavy prototyping.

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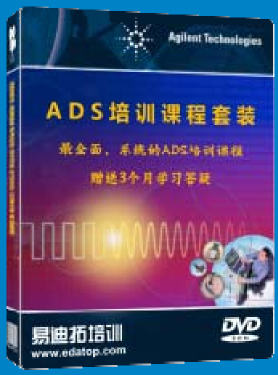

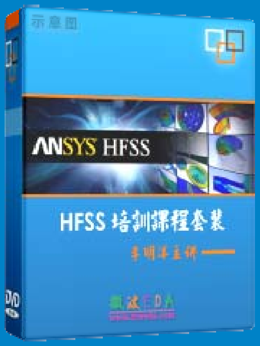

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