Electromagnetic Property of Capacitor Based on ADS and CST Simulation

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Abstract. In this paper, the electromagnetic property of capacitor is carefully studied using 3-D electromagnetic simulation software CST MWS.Since CST is still a new software which has not been widely acknowledged and used widely,there is likely to exist inaccuracy calculation in low frequency range using Time Domain solver. In order to examine the result,ADS, a more reliable simulation software is adopted. By combine the CST and ADS together, the capacitor characteristics is depicted precisely.

Introduction

With the rapid development of 3-D electromagnetic simulation technology, it becomes reality that prototypes can be simulated with regards of the space relationship.However,it has also aroused disputes in 3-D modelings on calculation accuracy using Time Domain Solver. This paper presented here is committed to the research of the electromagnetic property of capacitor based on CST,combined with the verification of ADS.

X capacitor Modeling

The actual capacitor (Fig.2) is manufactured with conductive film layer inside. For modeling in detail is complicated, the model is simplified to be filled with internal normal conductor. Two thin dielectrics are attached to the normal conductor, covered with identical pieces of perfect conductor outside, from which the wire is led with length 5mm each.

Measurement is carried out precisely to ensure the modeling veracity. Consequently, the capacitor is modeled resembling the prototype, as is shown in Fig.2.

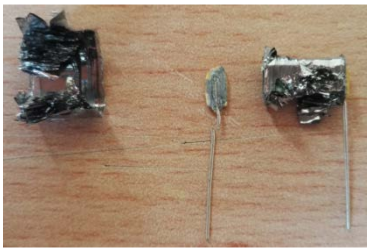


Fig.1 X capacitor prototype and the inner structure

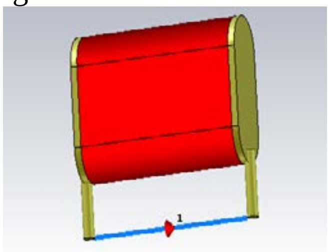


Fig.2 X capacitor model

Z-parameter USING CST

The background substance is selected as air and is extended 20 mm outward from the model in three directions. The default mesh dissection is adopted. The external boundary is set as short-circuit boundary E_t=0. Thus S-parameter is obtained (Fig.3) using CST.

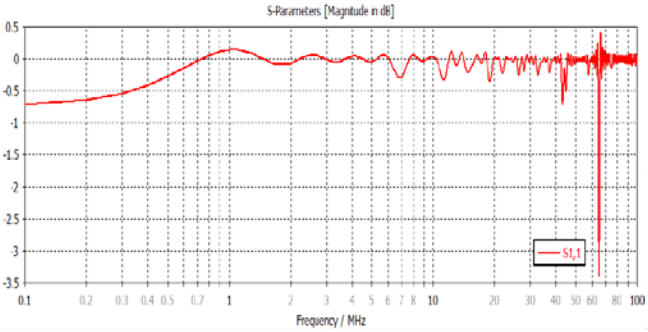


Fig.3 S-parameters of X capacitor

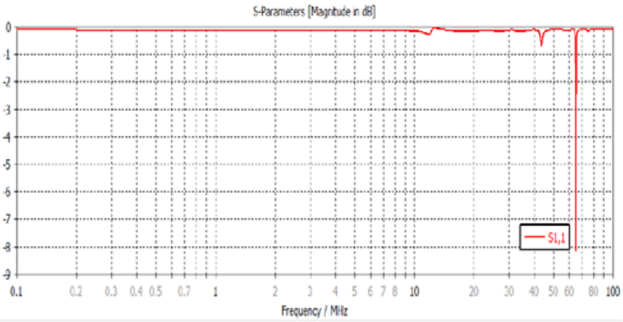


Fig.4 S-parameter after AR filter of X capacitor

As oscillation and energy divergence occurred in the graph above,the default AR filter setting is used to post-process the data. The result after AR filter is illuminated in Fig.4. Likewise,Z-parameter and Z-parameter after AR filter is shown in Fig5 and Fig.6 respectively:

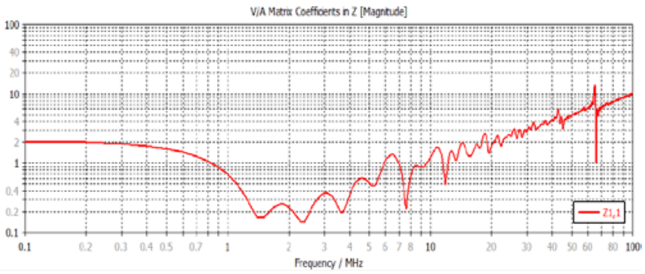


Fig.5 Z-parameters of X capacitor

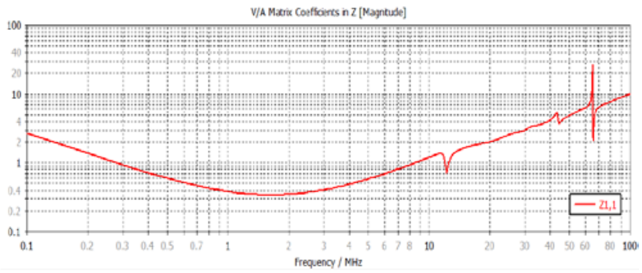


Fig.6 Z-parameter after AR filter of X capacitor

To calculate the RLC value, three marks are attached to the graph as below(Fig.7). According to the coordinates, the impedance at 0.2 MHz is 1.37 Ohm, thus the capacitance is 0.58 uF. In addition,the impedance is 3 Ohm at 30MHZ,the inductance value is 15.9 nH. As the dielectric loss factor at the second mark is 0.001,the impedance is 0.343 Ohm at 1.66 MHz. Therefore, the RLC values in series connection are determined.

It should be noted, however, that the design value of the prototype is 0.33 uF, which is inconsistent with 0.85uF calculated from Z-parameters. Apart from the negligible error in modeling, the difference probably lies in the inaccuracy of CST MWS applied in low frequency range.

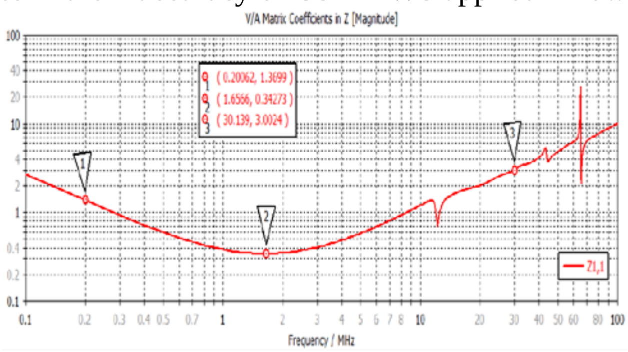


Fig.7 Z-parameter after AR filter of X capacitor attached with marks

Verification of Low Frequency Cst Simulation

To verify the calculation of CST,an RLC equivalent circuit is created in ADS(Fig.8). In addition,the CST result is exported as *.S1P document and imported into the ADS later to be simulated. RLC Equivalent circuit result is compared with the ADS S1P full wave result.(Fig.9 and Fig.10)

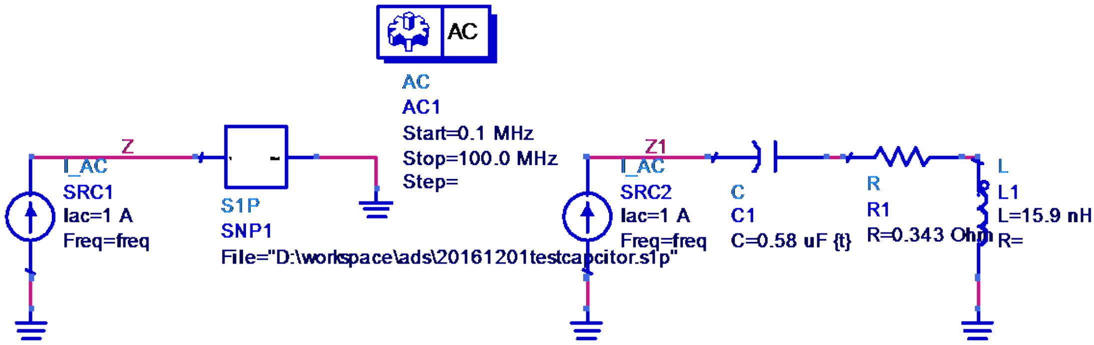
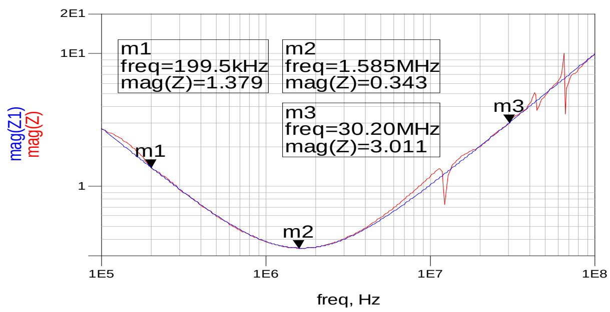


Fig.8 LEFT:ADS simulation of *S1P document; RIGHT:ADS simulation of RLC equivalent circuit.



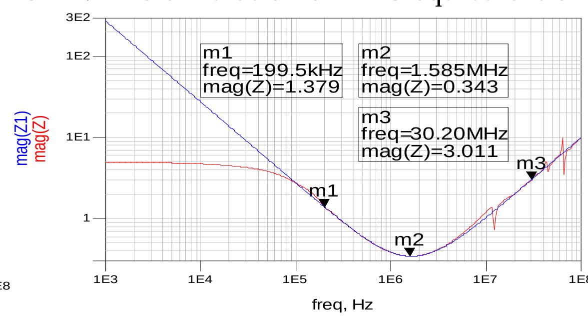


Fig.9 Two simulation curves in high frequency. Fig.10 Two simulation curves in low frequency.
(RED:ADS simulation of *S1P document; BLUE:simulation of equivalent circuit.)

It is concluded from Fig.9 that the parameters in the equivalent circuit are accurate.Z-parameter generated from *S1P agrees with the result of ADS equivalent circuit in higher frequency but deviates considerably especially under 0.1 MHz(Fig.10),which also fortifies the presumption of inaccuracy.

Reinforcement of CST incorrectness

To reinforce the presumption, the ADS simulation(Fig.11) is taken with capacitance value of 0.58 uF and 0.33 uF. Comparison between S-parameters and Z-parameters of the two simulations and the ADS calculation result of *S1P is presented in Fig17(0.58 uF) and Fig.13(0.33 uF) respectively.

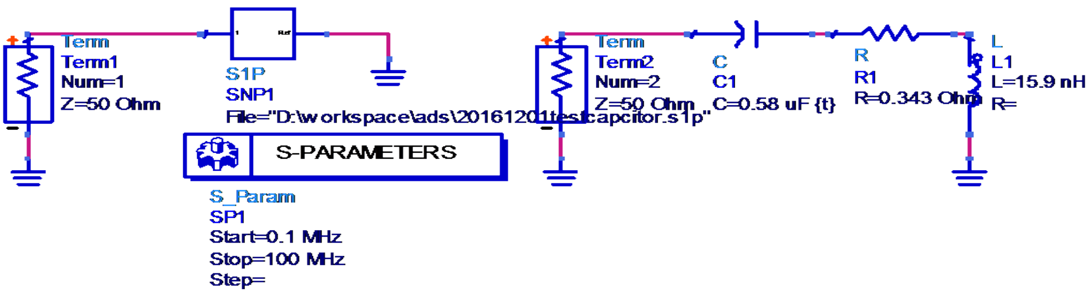


Fig.11

Fig.11 shows that S-parameters change slightly below 2MHz,while Z-parameters change dramatically. Slight fluctuation of S-parameter results in drastic impedance difference in low frequency.

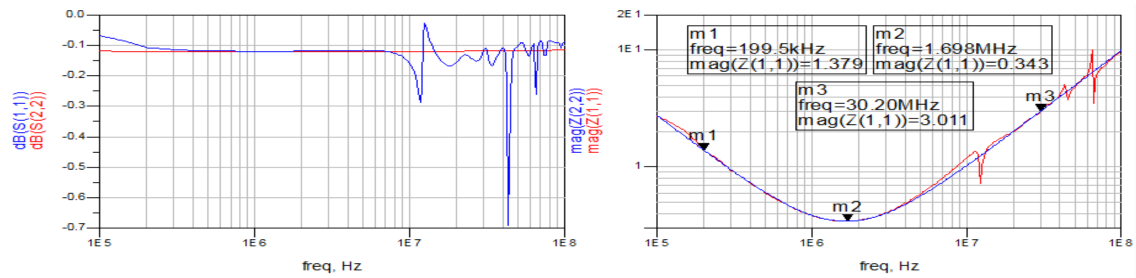


Fig.12 Comparison between results of ADS and CST when the capacitor is 0.58 uF. LEFT:S-parameters RIGHT:Z-parameters.

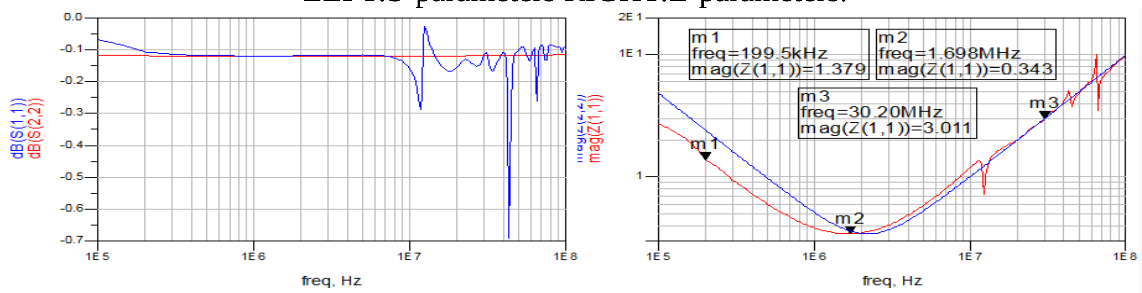


Fig. 13 Comparison between results of ADS and CST when the capacitor is 0.33 uF. LEFT:S-parameters RIGHT:Z-parameters.

Conclusion

Capacitor has been successfully modeled in CST. S-parameters and Z-parameters have been acquired. Since there remains deviation between the capacitance value in the equivalent circuit and the design value of the prototype, verification is conducted using ADS. According to comparisons between CST result and the simulation of equivalent circuit in ADS, the characteristics deduced from CST is valid in higher frequency. On the contrary, due to the flaw of the time domain solver in CST,Z-parameters calculated is in precise. Hence, the electromagnetic property calculated from CST only holds true in high frequency. It requires still further consideration in search of the precise capacitance value through the conversion from S-parameter to Z-parameter using CST.

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