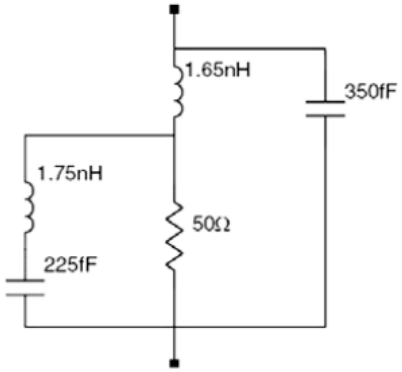
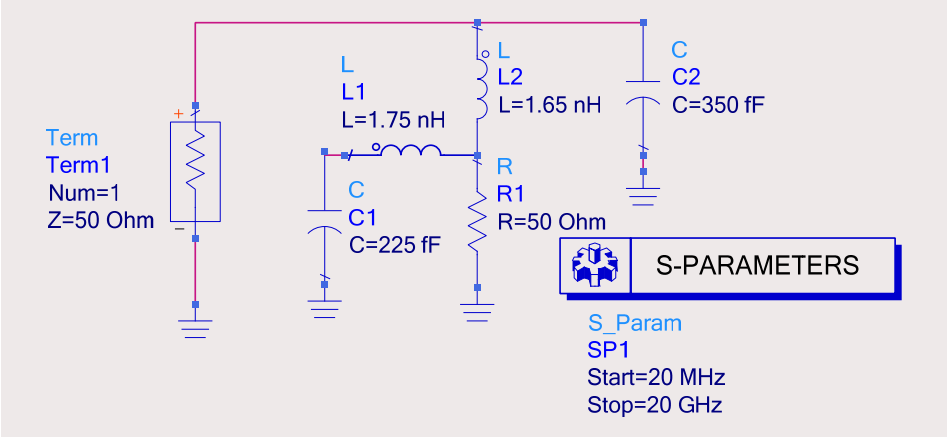
Dr. J. E. Rayas-Sánchez

S-PARAMETERS OF A THIN-FILM RESISTOR

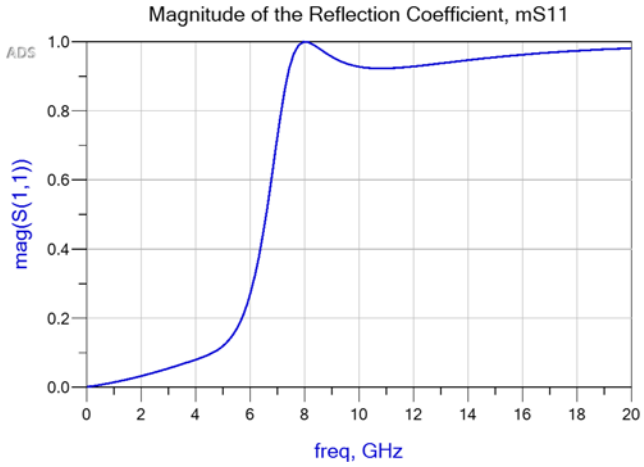
The thin-film chip resistor type 0603, illustrated below, can be modeled by the following equivalent lumped circuit [1]:

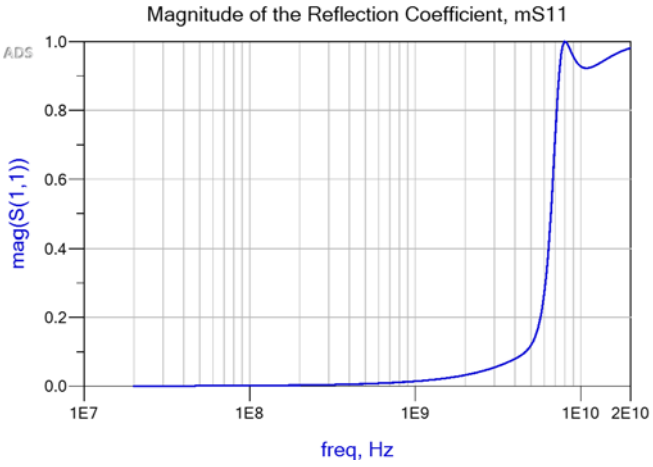


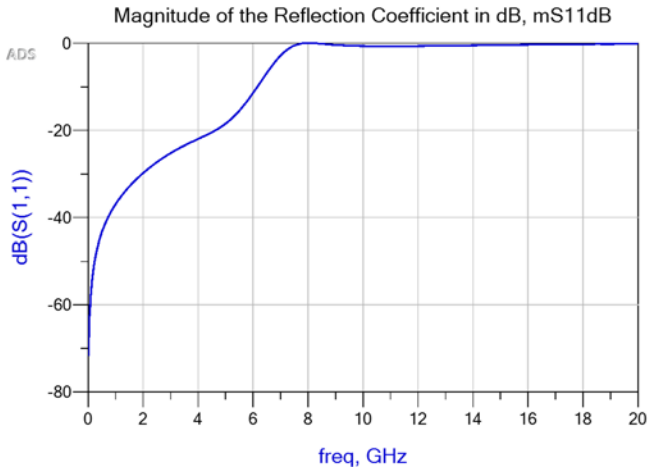
Implement in Keysight ADS the equivalent lumped circuit of this commercial resistor as a one-port network for S-parameters frequency-domain analysis, as shown below:

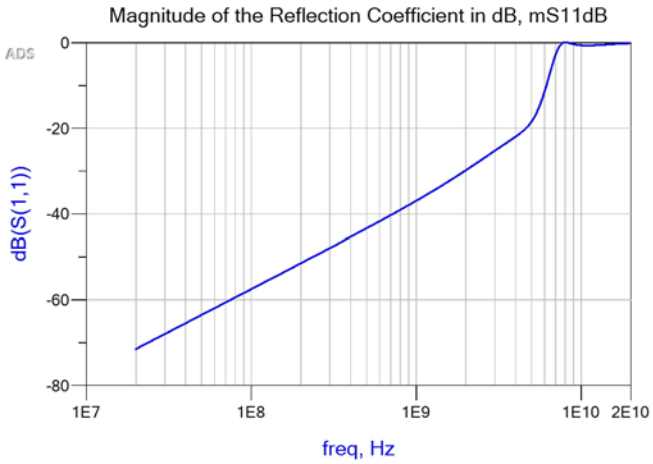


Use a reference impedance of 50 Ω. Perform the analysis from 20 MHz to 20 GHz with a logarithmic frequency sweep, with 100 frequency points per decade. Obtain the following plots for $|S_{11}|$:

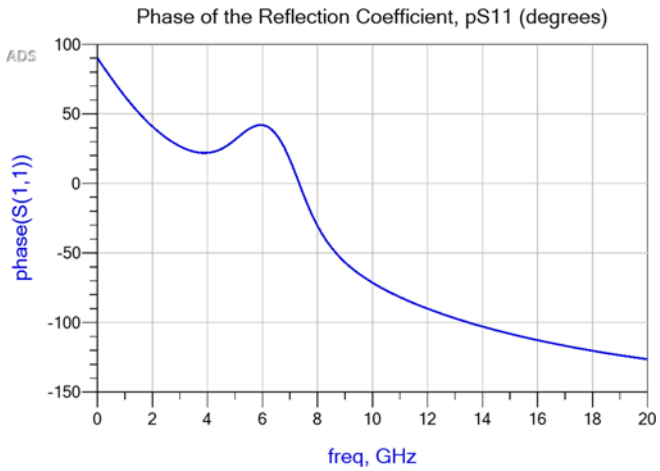


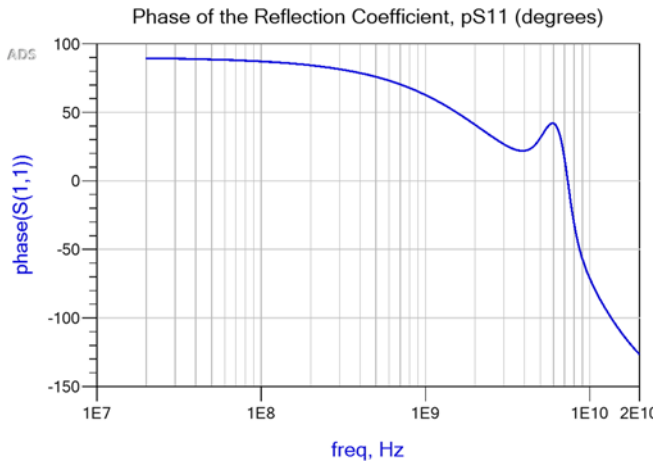






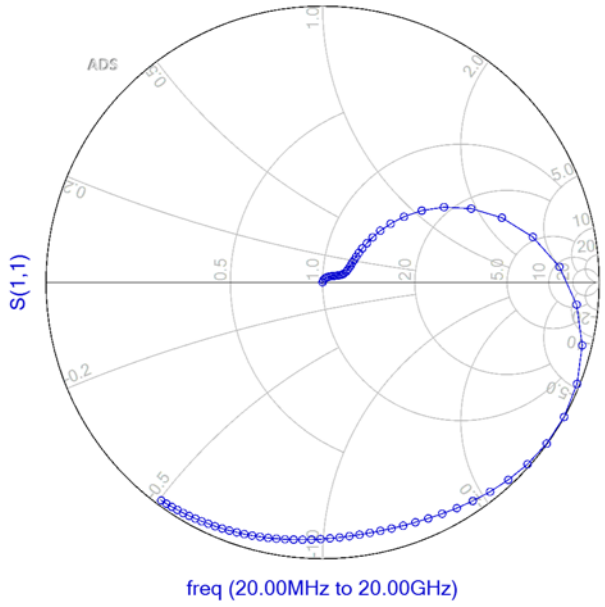
Now plot the phase of S_{11}:





From all the above plots, up to what frequency (approximately) can this resistor be used as a good terminator? Which is the dominant behavior of the resistor (capacitive or inductive) at high frequencies? Why is the phase of S_{11} equal to 90° at low frequencies?

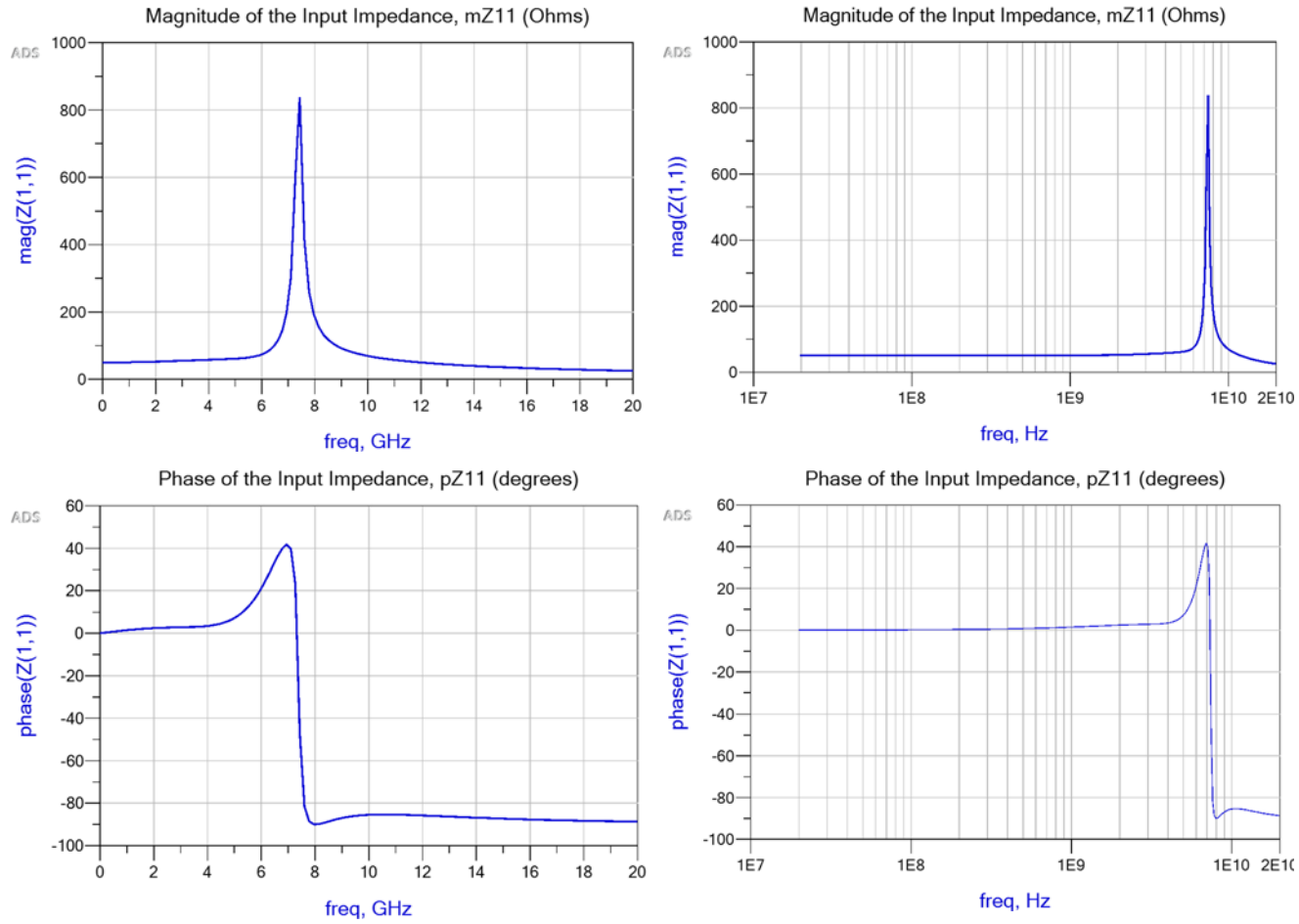
Now plot S_{11} in a Smith chart:



In the Smith chart plot, where is the zone of low frequency? Where is the zone of high frequencies?

From all the previous plots, at what frequency (approx.) does S_{11} crosses the horizontal axis in the Smith chart?

Change the analysis configuration (S-PARAMETERS block) such that you now calculate the Z-parameters. Plot the magnitude and phase of Z_{11}, as follows:



From the above plots, up to what frequency (approximately) does this resistor behave as an almost ideal 50-Ω resistor? What is happening at the resonance (little more than 7 GHz)?

[1] J. Seams, "A comparison of resistive terminators for high speed digital data transmission," *High-Frequency Electronics Mag.*, vol. 4, no. 8, pp. 18-26, Oct. 2005.