Space Mapping Problem:
Capacitively-Loaded 10:1 Two-Section Impedance Transformer (Chebyshev)

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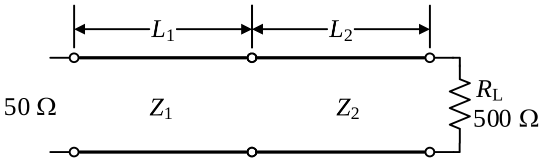
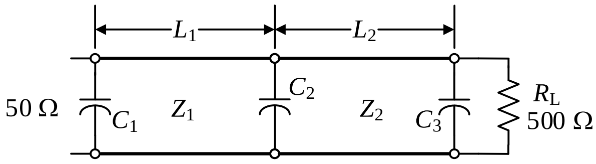
Coarse Model



ideal transmission lines

Fine Model



capacitively-loaded ideal transmission lines
C_1 = 0.4pF, C_2 = 0.2pF, C_3 = 0.1pF

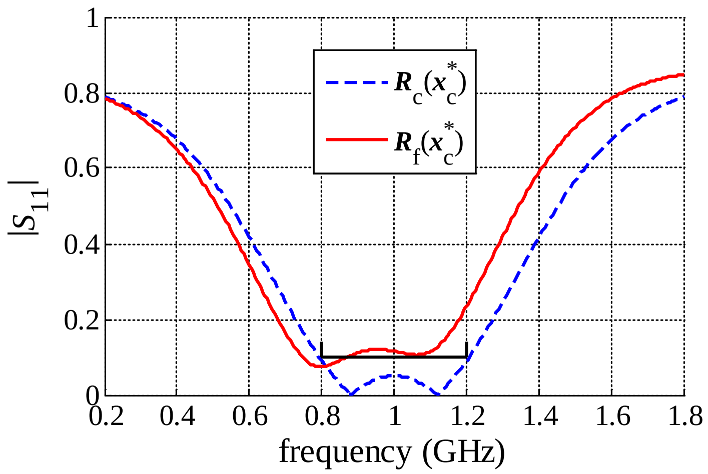
Reference impedance is Z_0 = 50 Ω. Load impedance is R_L = 500 Ω. The transmission lines characteristic impedances in both models are kept fixed at the following values: $Z_1 = 1.8233Z_0$ Ω, $Z_2 = 5.4845Z_0$ Ω, using coefficients for Chebyshev profile with a 10:1 transformation ratio and a 0.05 ripple [1].

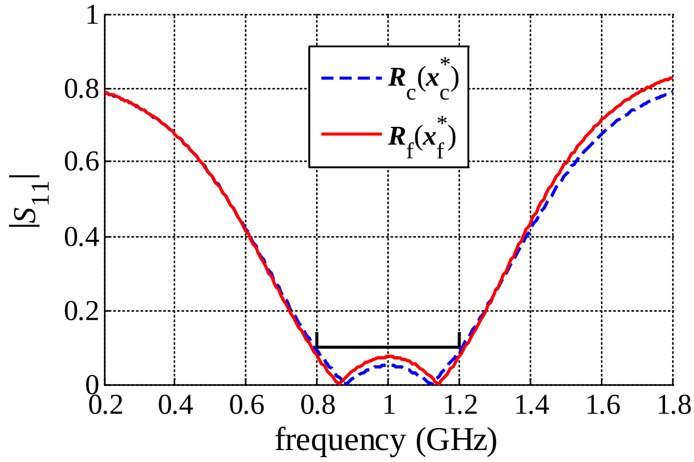
Specifications (Z_0 = 50 Ω):

$$|S_{11}| \le 0.1 \text{ for } 0.8 \text{ GHz} \le f \le 1.2 \text{ GHz}$$

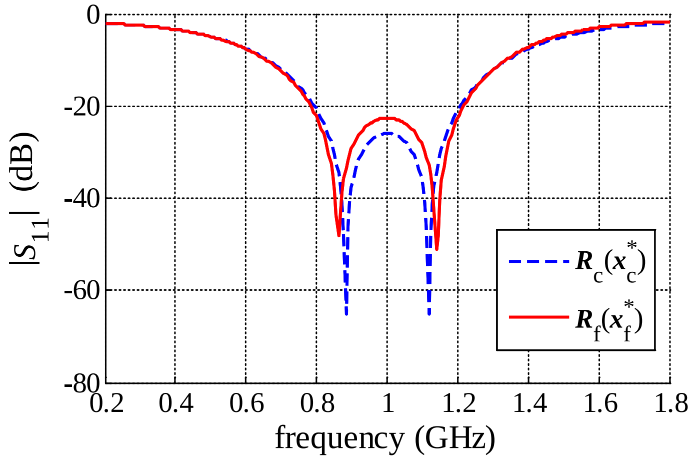
Design variables: $\boldsymbol{x} = [L_1 \quad L_2]^T$ (degrees)
$\boldsymbol{x}_c^* = [90 \;\; 90]^T$ (degrees), exact analytic solution.
$\boldsymbol{x}_f^* = [79.067 \quad 88.6166]^T$ (degrees), with minimax objective function $U(\boldsymbol{x}_f^*) = -0.024894$.

Using p = 301 frequency points uniformly distributed from 0.2 GHz to 1.8 GHz for plotting.





$R_c(x_c^*)$
$R_f(x_f^*)$
$|S_{11}|$
frequency (GHz)



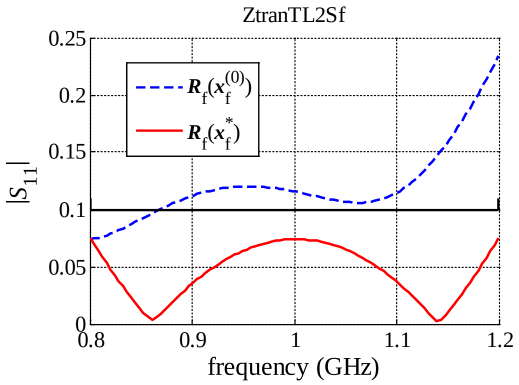
$R_c(x_c^*)$
$R_f(x_f^*)$
$|S_{11}|$ (dB)
frequency (GHz)

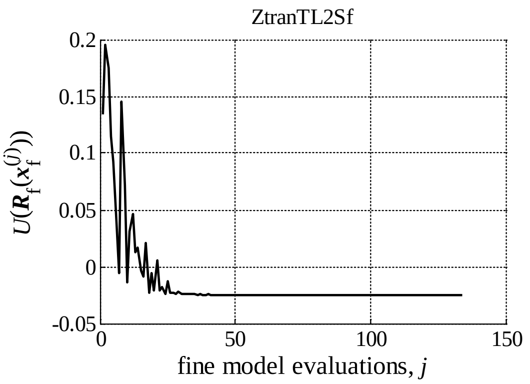
Direct Optimization of the Fine Model (for comparison with SM methods)

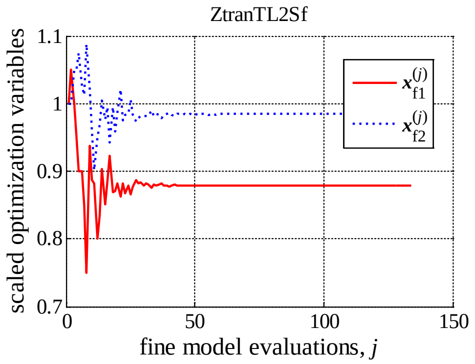
Using $\boldsymbol{x}_\mathrm{f}^{(0)} = \boldsymbol{x}_\mathrm{c}^* = [90\ \ 90]^\mathrm{T}$ (degrees), with p = 100 for plotting and for calculating objective function.

Nelder-Mead method

TolFun = 1e-7, TolX = 1e-7





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Total number of model evaluations: 134
Xopt = [79.067 88.6166]
Objective function value at Xopt = -0.024894
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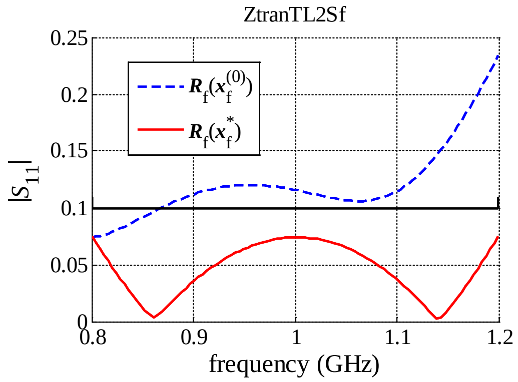
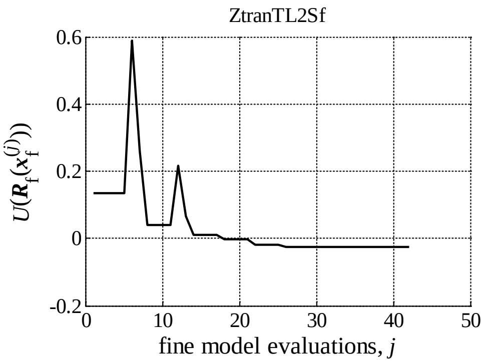
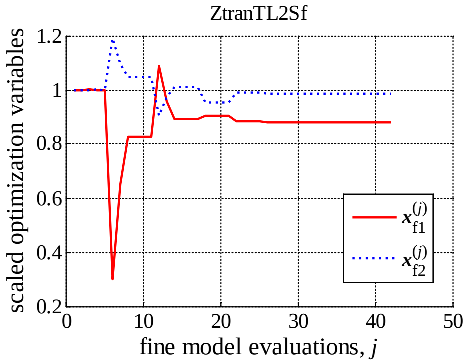
SQP method

TolFun = 1e-7, TolX = 1e-7, DiffMinChange = 10TolX, TolCon = 1e-05; and $\boldsymbol{x}^{\mathrm{lb}} = 0.3\boldsymbol{x}^{(0)}$, $\boldsymbol{x}^{\mathrm{ub}} = 3\boldsymbol{x}^{(0)}$





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Total number of model evaluations: 42
Xopt = [79.067 88.6166]
Objective function value at Xopt = -0.024894
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[1] D. M. Pozar, *Microwave Engineering*. Amherst, MA: Wiley, 1998.