Space Mapping Problem:
Capacitively-Loaded 2:1 One-Section Impedance Transformer

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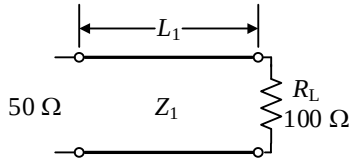
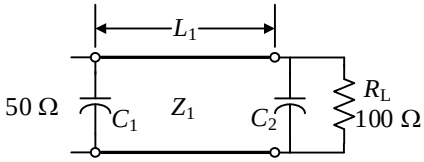
Coarse Model



ideal transmission line

Fine Model



capacitively-loaded ideal transmission line
C_1 = 0.5pF, C_2 = 0.05pF

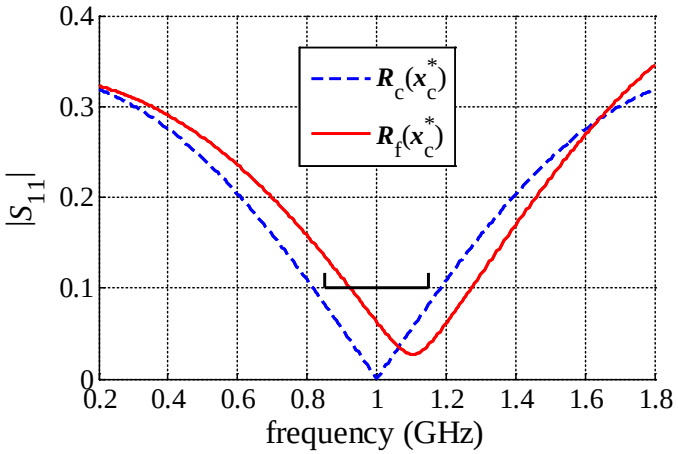
Reference impedance is Z_0 = 50 Ω. Load impedance is R_L = 100 Ω. The transmission line characteristic impedance in both models is kept fixed at the following value: Z_1 = sqrt(Z_0R_L) = 70.7107 Ω [1].

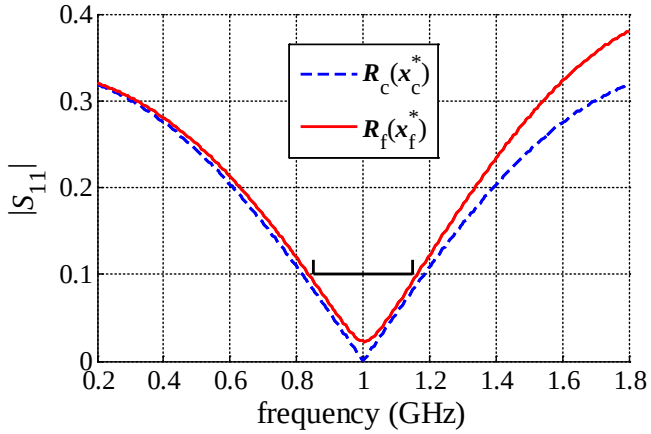
Specifications (Z_0 = 50 Ω):

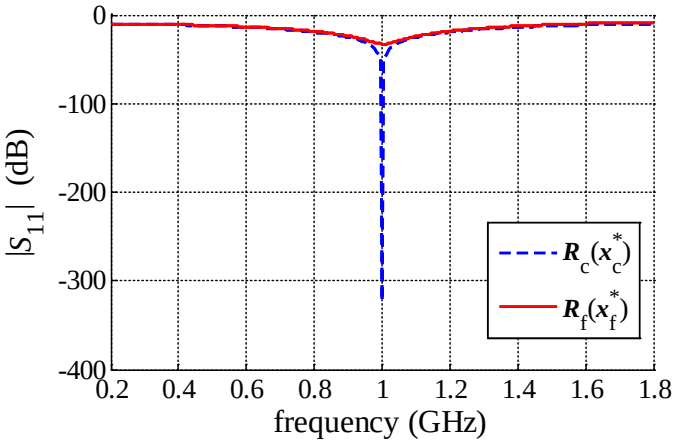
$$|S_{11}| \le 0.1 \text{ for } 0.85 \text{ GHz} \le f \le 1.15 \text{ GHz}$$

Design variables: $\boldsymbol{x} = L_1$ (degrees)
$\boldsymbol{x}_c^* = 90$ (degrees)
$\boldsymbol{x}_f^* = [98.3721]^T$ (degrees), with $U(\boldsymbol{x}_f^*) = -0.0074962$ using p = 10 within specs.

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




0.4
0.3
0.2
0.1
0
|S11|
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
frequency (GHz)
$R_c(x_c^*)$
$R_f(x_f^*)$

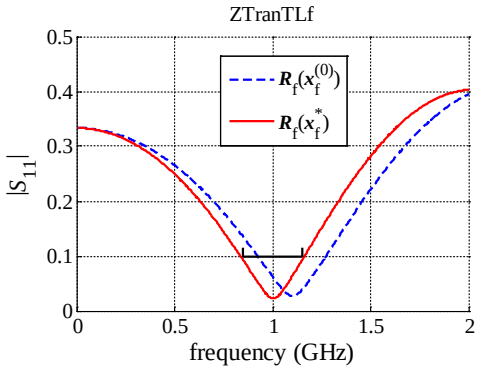

0
-100
-200
-300
-400
|S11| (dB)
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
frequency (GHz)
$R_c(x_c^*)$
$R_f(x_f^*)$

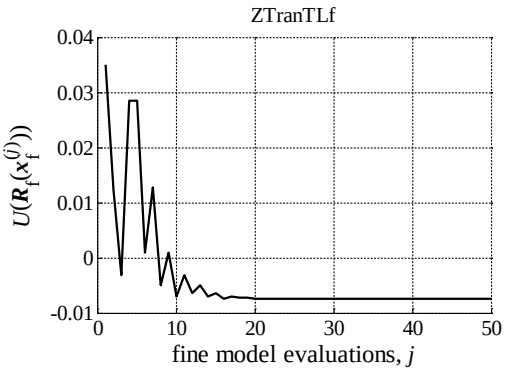
Direct Optimization of the Fine Model (for comparison with SM methods)

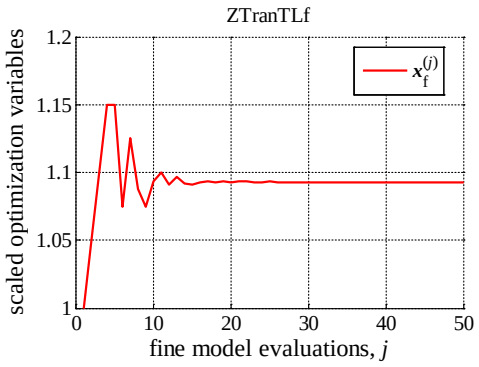
Using $\boldsymbol{x}_f^{(0)} = \boldsymbol{x}_c^* = 90$ (degrees), with $p = 501$ for plotting and calculating objective function with $p = 5$ for the specified frequency range.

Nelder-Mead method

TolFun = 1e-8, TolX = 1e-8





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Total number of model evaluations: 50
Xopt = 98.3721
Objective function value at Xopt = -0.0074962
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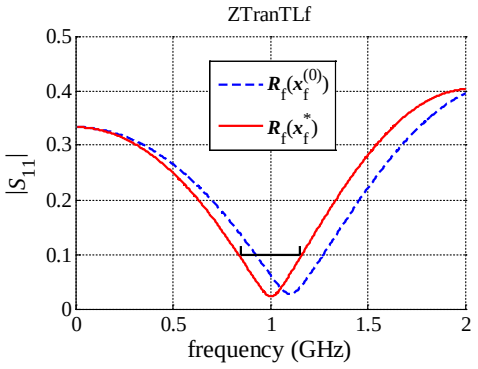
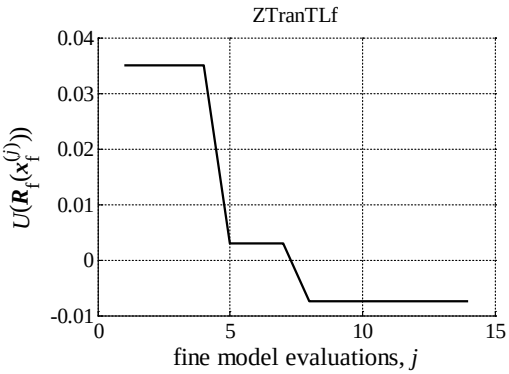
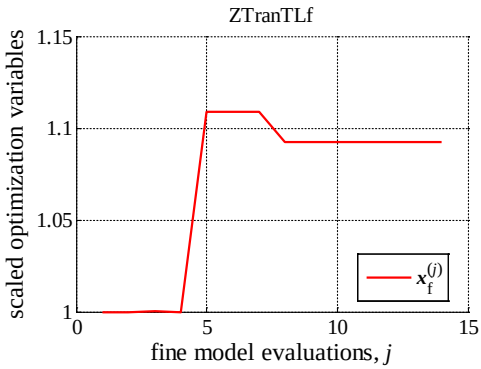
SQP method

TolFun = 1e-8, TolX = 1e-8, DiffMinChange = 10TolX, TolCon = 1e-05; and $\boldsymbol{x}^{lb} = 0.3\boldsymbol{x}^{(0)}$, $\boldsymbol{x}^{ub} = 3\boldsymbol{x}^{(0)}$





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Total number of model evaluations: 14
Xopt = 98.3721
Objective function value at Xopt = -0.0074962
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[1] D. M. Pozar, *Microwave Engineering*. Amherst, MA: Wiley, 1998.