SIMULATION OPTIMIZATION SYSTEMS
Research Laboratory

A NEW SPACE MAPPING ALGORITHM FOR EM OPTIMIZATION

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Basic Concepts

it is assumed that the circuit under consideration can be simulated using two models: a fine model and a coarse model

the fine model is accurate but is computationally intensive

$\boldsymbol{x}_{em}$ is the vector of fine model parameters

the coarse model is a fast model but it is less accurate than the fine model

$\boldsymbol{x}_{os}$ is the vector of coarse model parameters

space mapping aims at avoiding the computationally intensive direct optimization of the fine model

Comments on the Parameter Extraction Step

the parameter extraction step aims at finding a point $\boldsymbol{x}_{os}$ whose coarse model responses match corresponding fine model responses

the extracted coarse model parameters may be nonunique

nonuniqueness of the parameter extraction step hinders the convergence of the aggressive Space Mapping technique

The Multi-Point Parameter Extraction

to overcome problems caused by nonuniqueness of the parameter extraction step a multi-point parameter extraction step was suggested (*Bandler et al., 1996*)

the step aims at matching not only the response but also the first-order derivative of the two models

the extracted coarse model point $\boldsymbol{x}_{os}$ is obtained by solving

$$\underset{\boldsymbol{x}_{os}}{\mathit{minimize}} \left\| \boldsymbol{R}_{os}(\boldsymbol{x}_{os} + \Delta\boldsymbol{x}) - \boldsymbol{R}_{em}(\boldsymbol{x}_{em} + \Delta\boldsymbol{x}) \right\|$$

simultaneously for a set of perturbations Δx

this step is more likely to improve the uniqueness of the parameter extraction step

Questions Regarding the Original Multi-Point Extraction

the original multi-point parameter extraction (*Bandler et al., 1996*) suffers from two main drawbacks

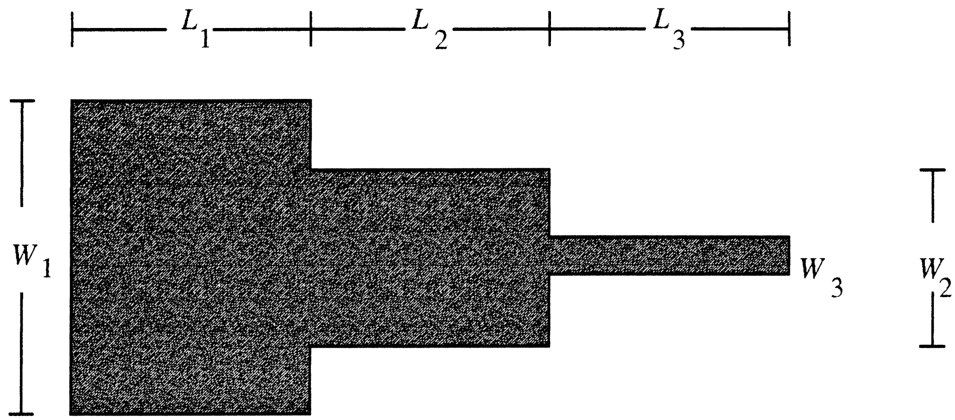
the first drawback is that the fine model points were arbitrarily selected

the second drawback is the assumption that a perturbation of $\Delta \boldsymbol{x}$ in the fine model space corresponds to an equal perturbation in the coarse model space

in the *i*th iteration, the most recent information about the mapping between the two spaces is given by the matrix $\boldsymbol{B}^{(i)}$, which should be integrated with the multi-point parameter extraction step

Three-Section 3:1 Microstrip Transformer

(*Bandler et al., 1994*)



source and load impedances 50 Ω and 150 Ω

design constraints $|S_{11}| \leq 0.11$ for the frequency range 5 GHz $\leq f \leq$ 15 GHz.

designable parameters: W_1, W_2, W_3, L_1, L_2 and L_3

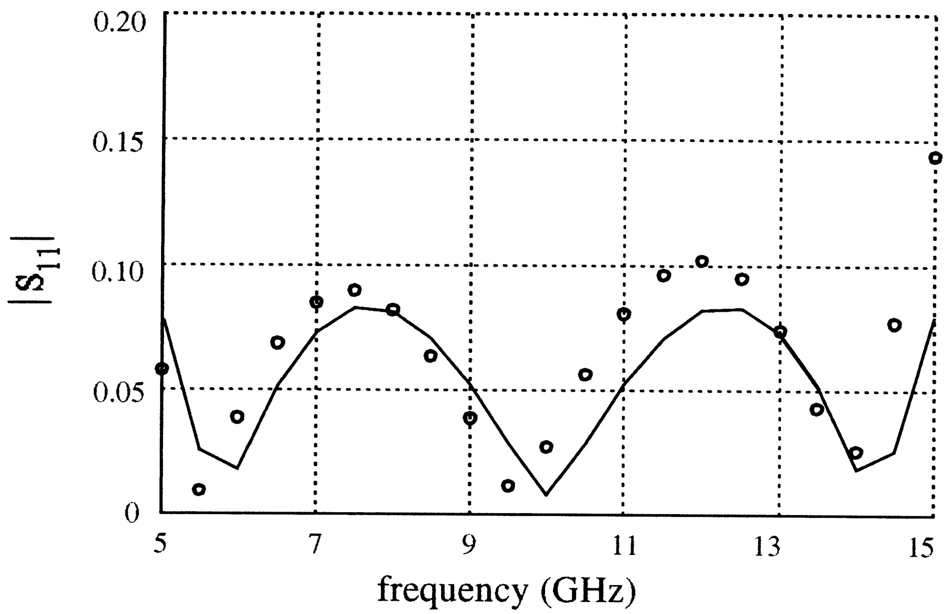
coarse model: ideal transmission-line model supplied by OSA90/hope

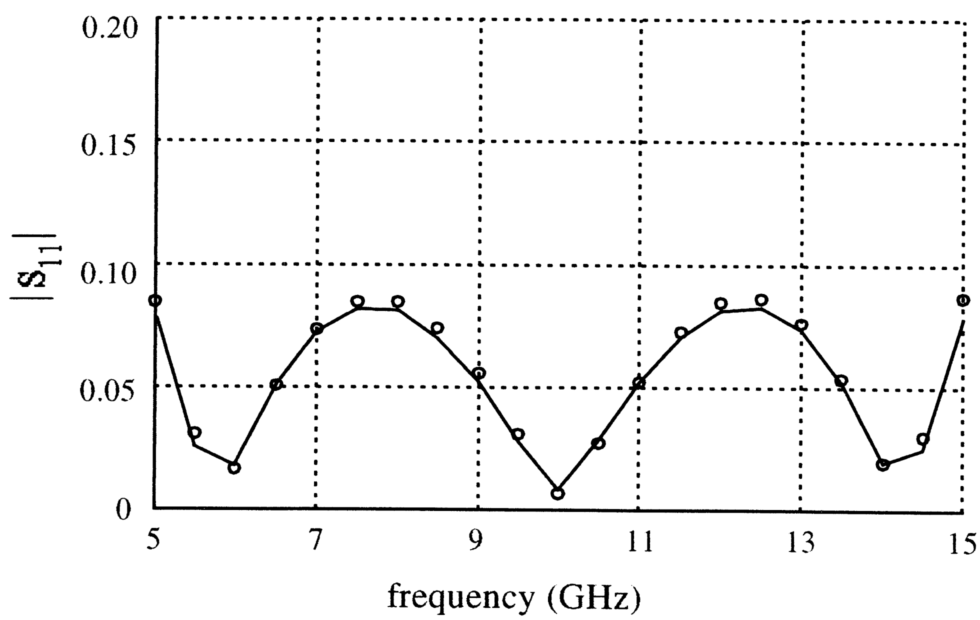
fine model exploits microstrip and microstrip step models supplied by OSA90/hope

the final solution is obtained in 2 iterations, requiring 6 fine model simulations

Three-Section 3:1 Microstrip Transformer Responses

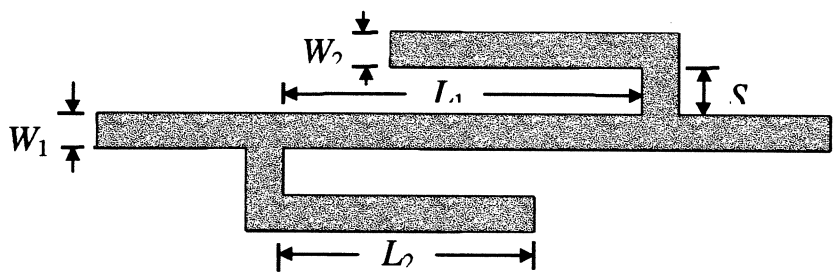
the optimal coarse model (—) response and the fine model response (o) at the initial and final designs





Double-Folded Stub Microstrip Filter

(*Rautio, 1992*)



passband specifications: $|S_{21}| \geq -3$ dB for $f \leq 9.5$ GHz and 16.5 GHz $\leq f$

stopband specifications: $|S_{21}| \leq -30$ dB for 12 GHz $\leq f \leq 14$ GHz

designable parameters: L_1, L_2 and S; W_1=W_2=4.8 mil

substrate thickness is 5 mil and the relative dielectric constant is assumed to be 9.9

coarse model: a coarse grid Sonnet ***em*** model with $\Delta x = \Delta y =$ 4.8 mil

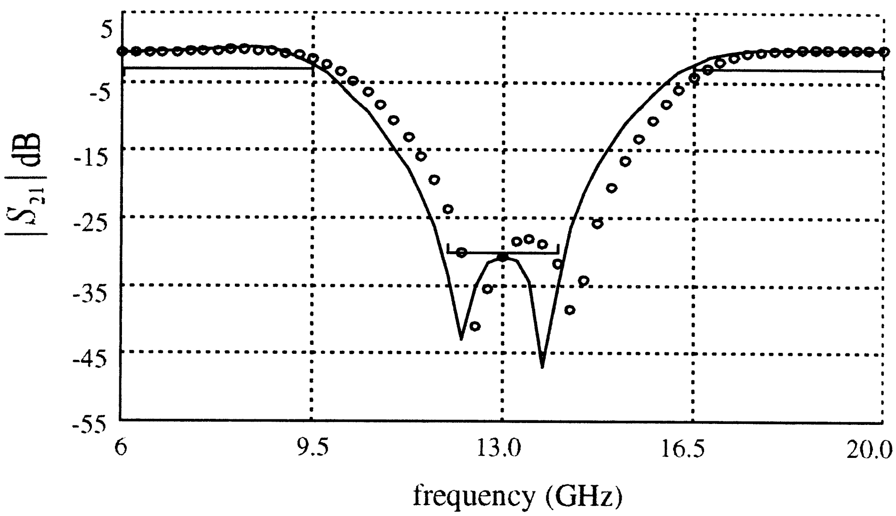
fine model: a fine grid Sonnet ***em*** model with $\Delta x = \Delta y =$ 1.6 mil

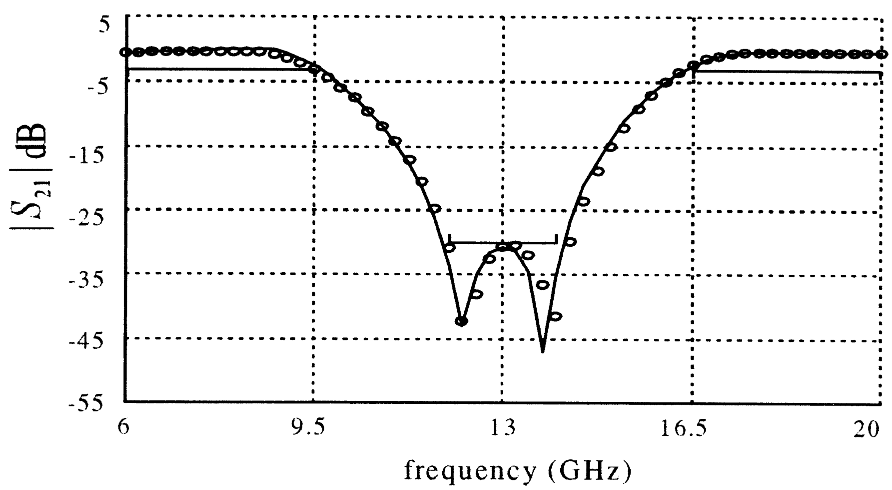
final design is obtained in 2 iterations, requiring 5 fine model points

OSA's Empipe linear interpolation is used to simulate off-grid points

Double-Folded Stub Microstrip Filter Responses

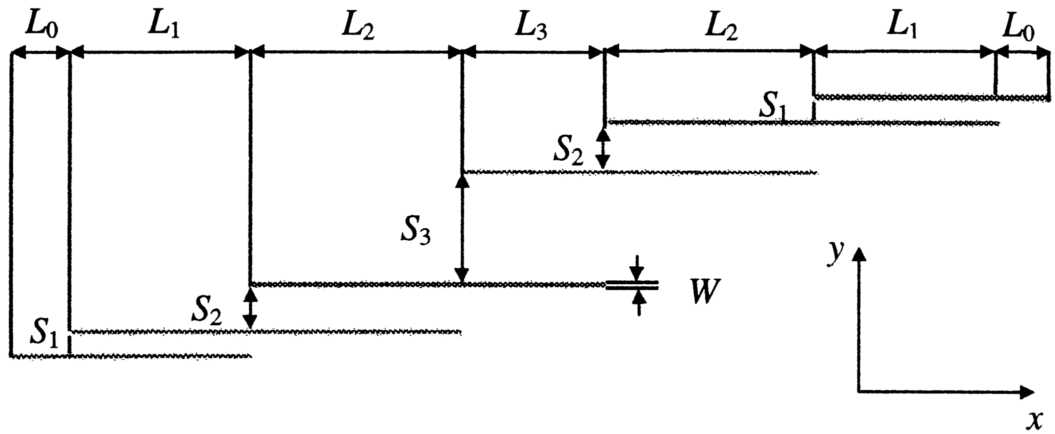
the optimal coarse model (—) response and the fine model response (o) at the initial and final designs





High-Temperature Superconducting Filter

(*Westinghouse, 1993*)



20 mil thick substrate

the dielectric constant is 23.4

passband specifications: $|S_{21}| \geq 0.95$ for $f \leq 3.967$ GHz and 4.099 GHz $\leq f$

stopband specifications: $|S_{21}| \leq 0.05$ for 4.008 GHz $\leq f \leq$ 4.058 GHz

designable parameters L_1, L_2, L_3, S_1, S_2 and S_3; L_0 and W are kept fixed

coarse model exploits the empirical models of microstrip lines, coupled lines and open stubs available in OSA90/hope

High-Temperature Superconducting Filter Fine Model

the fine model employs a fine-grid Sonnet ***em*** simulation

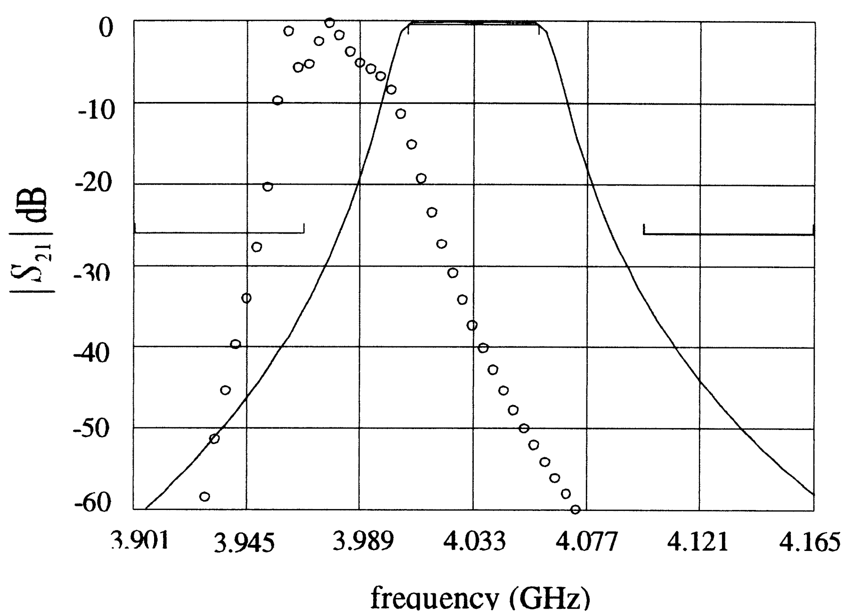
the *x* and *y* grid sizes for ***em*** are 1.0 and 1.75 mil

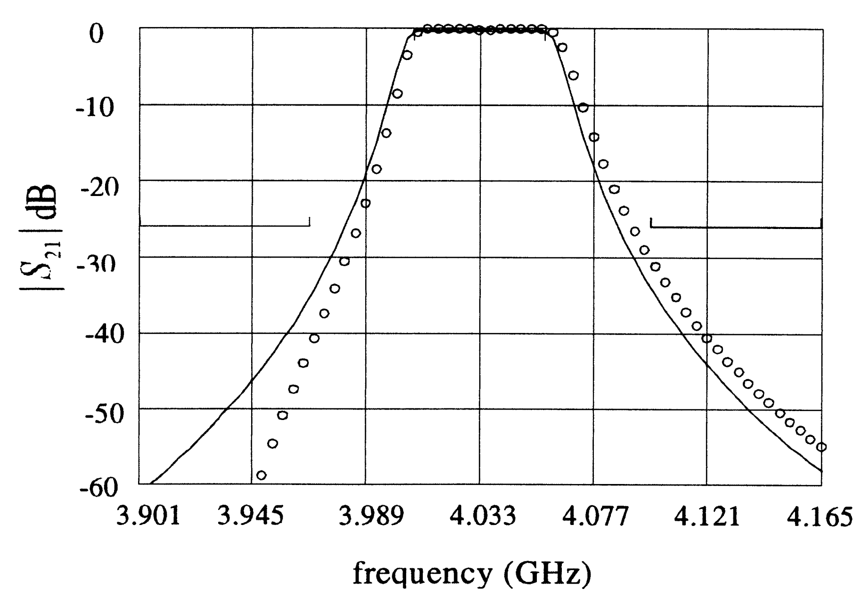
100 elapsed minutes are needed for ***em*** analysis at single frequency on a Sun SPARCstation 10

final design is obtained in 5 iterations, requiring 8 ***em*** simulations

High-Temperature Superconducting Filter Responses

the optimal coarse model (—) response and the fine model response (o) at the initial and final designs





Passband Details for the High-Temperature Superconducting Filter