TABLE I
THE OPTIMAL COARSE MODEL DESIGN AND THE DESIGNS
OBTAINED DURING DIFFERENT PHASES OF THE HASM ALGORITHM FOR
THE THREE-SECTION WAVEGUIDE TRANSFORMER

Parameter	x_{os}^*	First Phase Design	Second Phase Design	x_{em}^*
b_1	0.90318	0.90331	0.90114	0.90549
b_2	1.37093	1.36436	1.35687	1.35777
b_3	1.73609	1.73208	1.72470	1.71866
L_1	1.54879	1.46991	1.47203	1.47008
L_2	1.58375	1.56402	1.56521	1.57587
L_3	1.64590	1.79666	1.77744	1.78286

All values are in cm

TABLE II
THE OPTIMAL COARSE MODEL DESIGN, THE FINAL SPACE-MAPPED
AND THE OPTIMAL FINE MODEL DESIGNS FOR THE
SIX-SECTION H-PLANE WAVEGUIDE FILTER

Parameter	x_{os}^*	$\bar{x}_{em}$	x_{em}^*
W_1	0.48583	0.51326	0.51344
W_2	0.43494	0.47379	0.47396
W_3	0.40433	0.45091	0.45100
W_4	0.39796	0.44675	0.44664
L_1	0.65585	0.63701	0.63695
L_2	0.65923	0.63954	0.63977
L_3	0.67666	0.65704	0.65694

All values are in inches

$$J_{em} = J_{os}B$$

Space Mapping
x, f, B

Direct Optimization
x, J_{em}

$$B = \left(J_{os}^T J_{os}\right)^{-1} J_{os}^T J_{em}$$
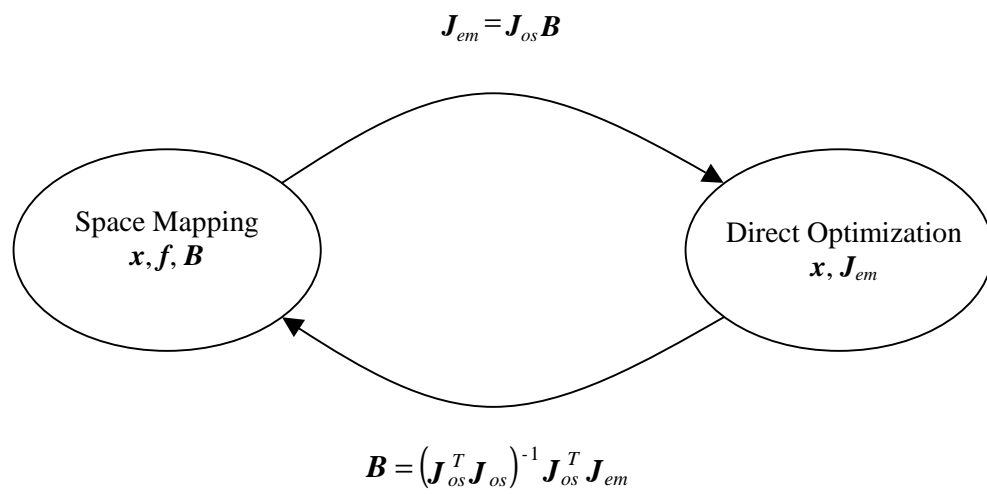
Fig. 1. Illustration of the connection between space mapping and direct optimization.

Given $\boldsymbol{x}_{em}^{(i)}$, $\boldsymbol{f}^{(i)}$, $\boldsymbol{B}^{(i)}$ and $\boldsymbol{d}^{(i)}$
Set $\boldsymbol{d}^{(i+1)} = \boldsymbol{d}^{(i)}$

Evaluate $\boldsymbol{h}^{(i)}$ using space mapping. and set $V = \{\boldsymbol{x}_{em}^{(i+1)}\}$

Obtain $\boldsymbol{f}_k^{(i+1)}$ using the points in V

Both success criteria satisfied?

Yes

Update $\boldsymbol{B}^{(i)}$ and $\boldsymbol{d}^{(i)}$

Set $i=i+1$

No

Direct optimization success criterion satisfied ?

No

Evaluate $\boldsymbol{J}_{em}^{(i)}$ from $\boldsymbol{J}_{os}^{(i)}$ and $\boldsymbol{B}^{(i)}$

Yes

$k=1$?

Yes

No

$\left\| \boldsymbol{f}_k^{(i+1)} - \boldsymbol{f}_{k\text{-}1}^{(i+1)} \right\| \leq \boldsymbol{e}$

Yes

Update $\boldsymbol{B}$ to get $\boldsymbol{B}^{(i+1)}$ and obtain $\boldsymbol{J}_{em}^{(i+1)}$ using $\boldsymbol{B}^{(i+1)}$ and $\boldsymbol{J}_{os}^{(i+1)}$

Phase 2

No

$k=n$?

Yes

Obtain $\boldsymbol{J}_{em}^{(i+1)}$ using the points in V

No

Obtain a temporary point $\boldsymbol{x}_t^k$ and set $V = V \cup \boldsymbol{x}_t^k$

Fig. 2. A flow chart of the first phase of the HASM algorithm.

12
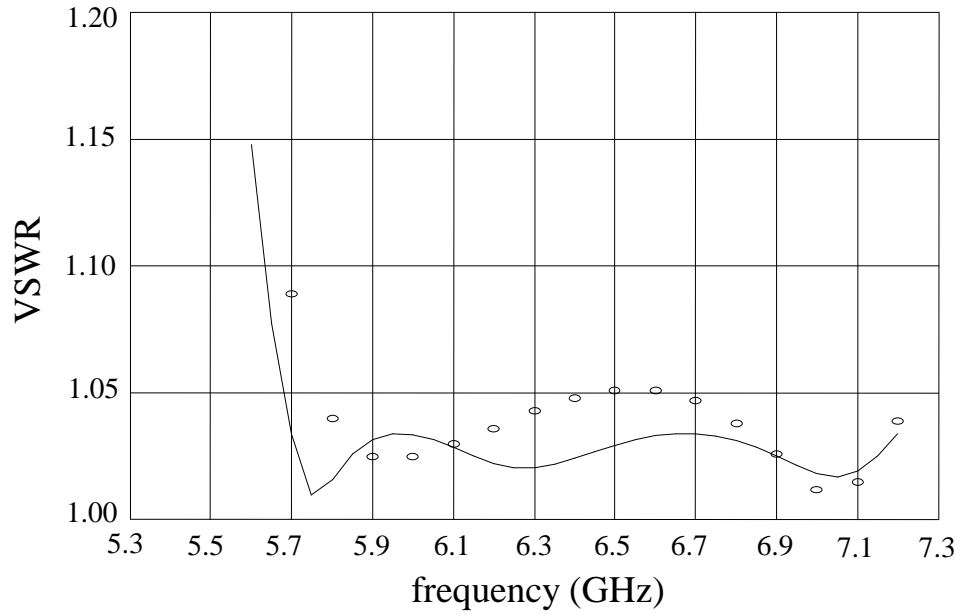
Fig. 3. The optimal coarse model response (—) and the fine model response (o) at the optimal coarse model design for the three-section waveguide transformer.
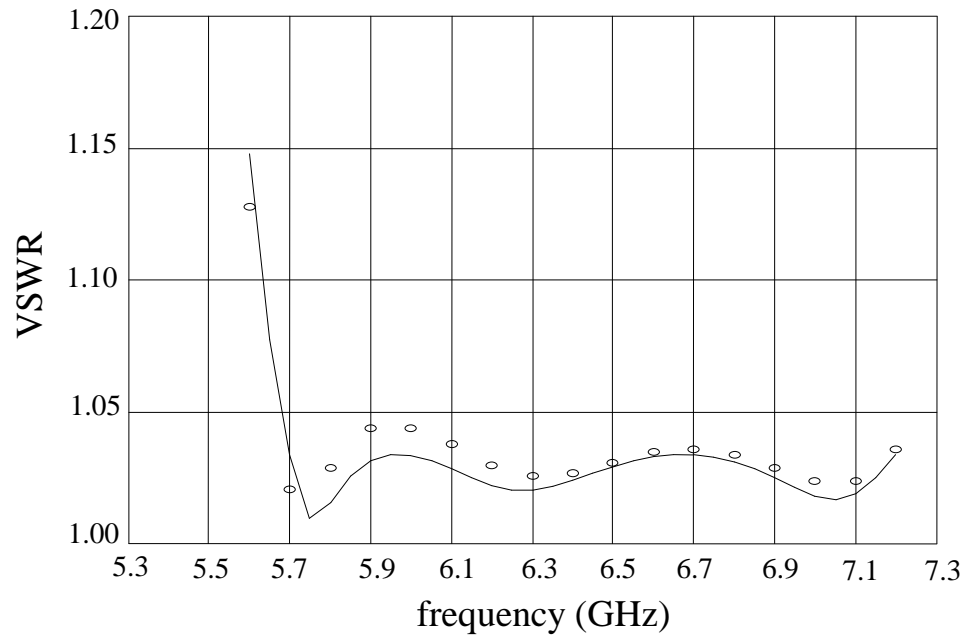

Fig. 4. The optimal coarse model response (—) and the fine model response (o) obtained at the end of the first phase of the HASM algorithm for the three-section waveguide transformer.
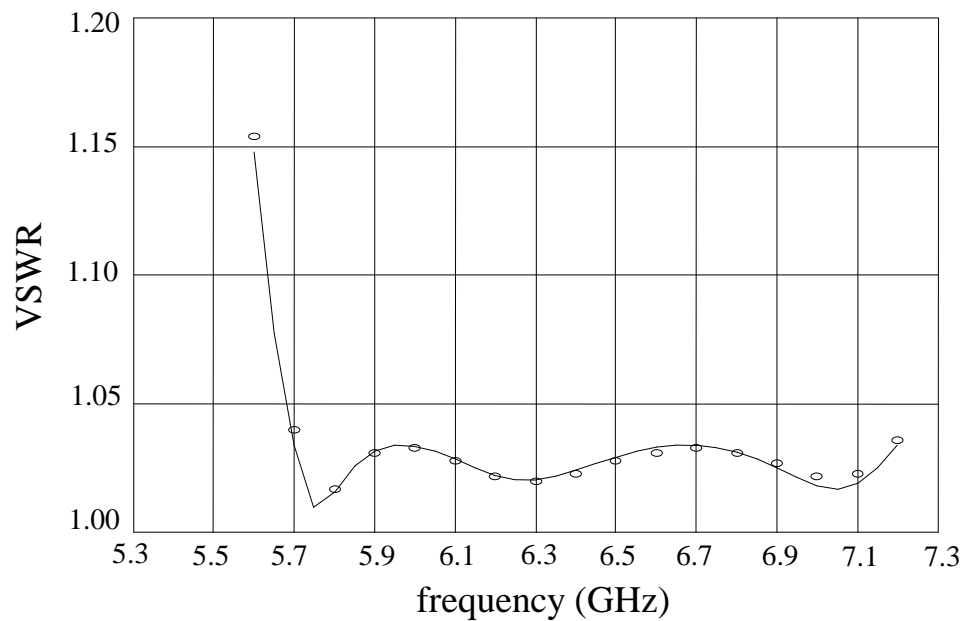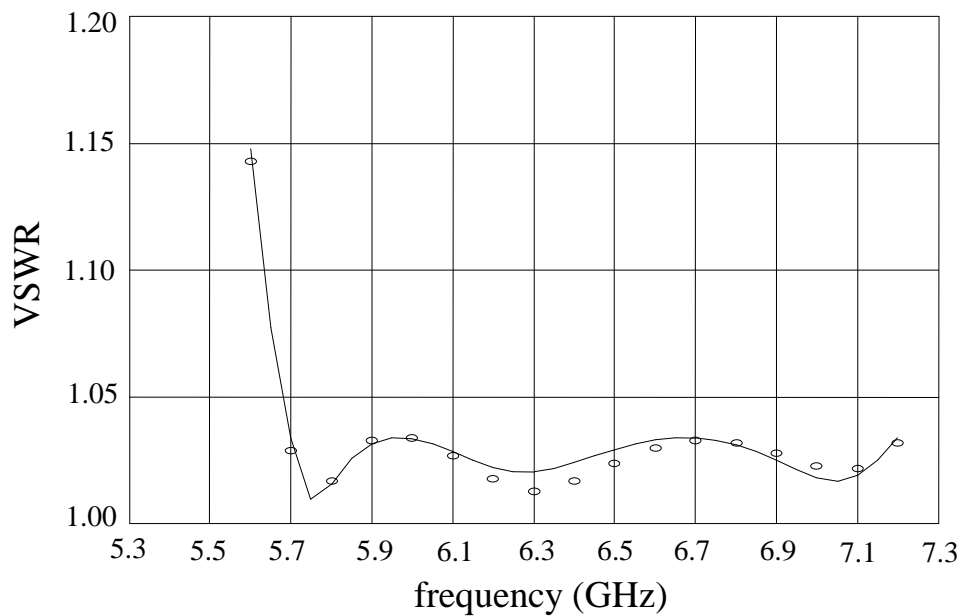
13

Fig. 5. The optimal coarse model response (—) and the fine model response (o) obtained at the end of the second phase of the HASM algorithm for the three-section waveguide transformer.

Fig. 6. The optimal coarse model response (—) and the minimax optimal fine model response (o) for the three-section waveguide transformer.

14
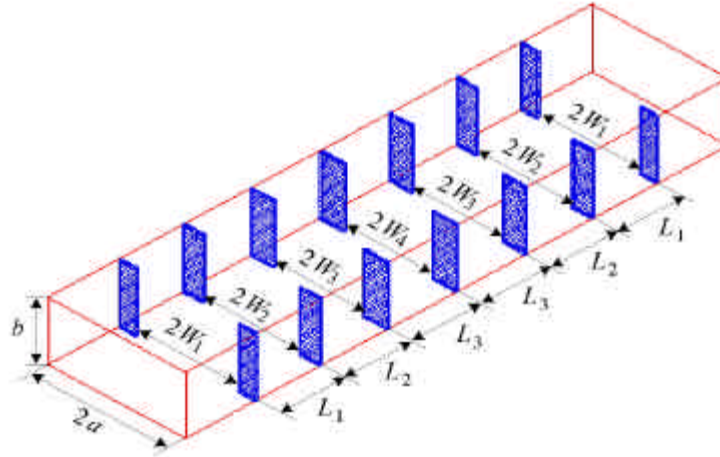
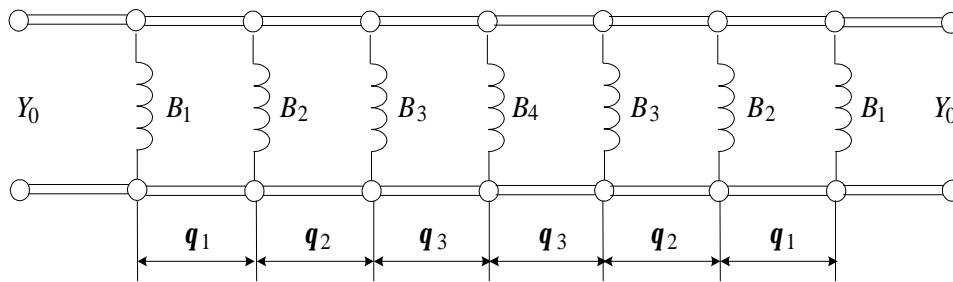Fig. 7. The fine model of the six-section waveguide filter [12, 13].

Fig. 8. The coarse model of the six-section waveguide filter [15].
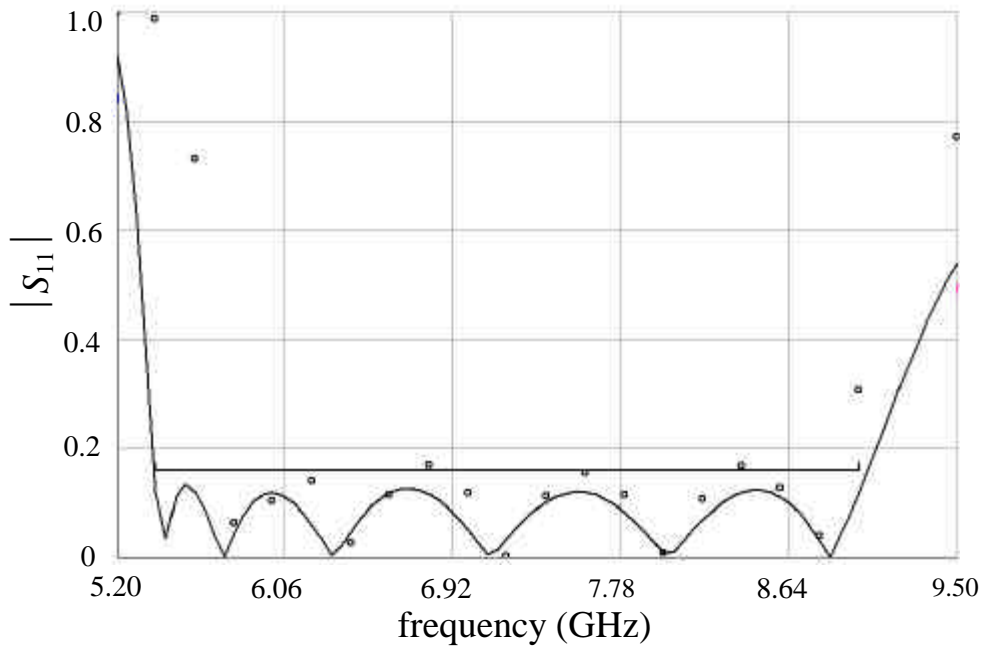

Fig. 9. The optimal coarse model response (—) and the fine model response (o) at the optimal coarse model design for the six-section waveguide filter.
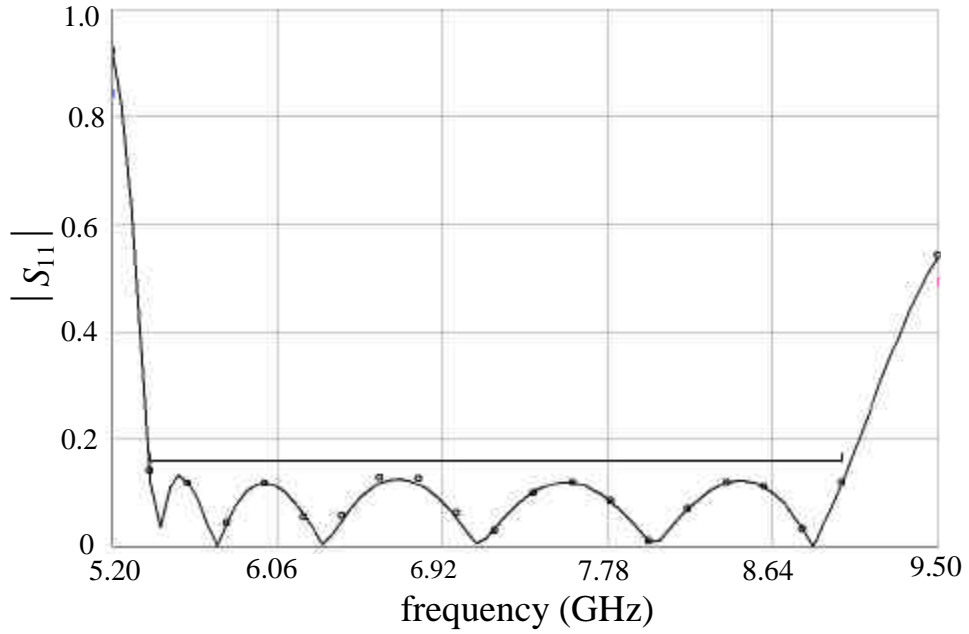
Fig. 10. The optimal coarse model response (—) and the fine model response (o) at the end of the second phase of the HASM algorithm for the six-section waveguide filter.
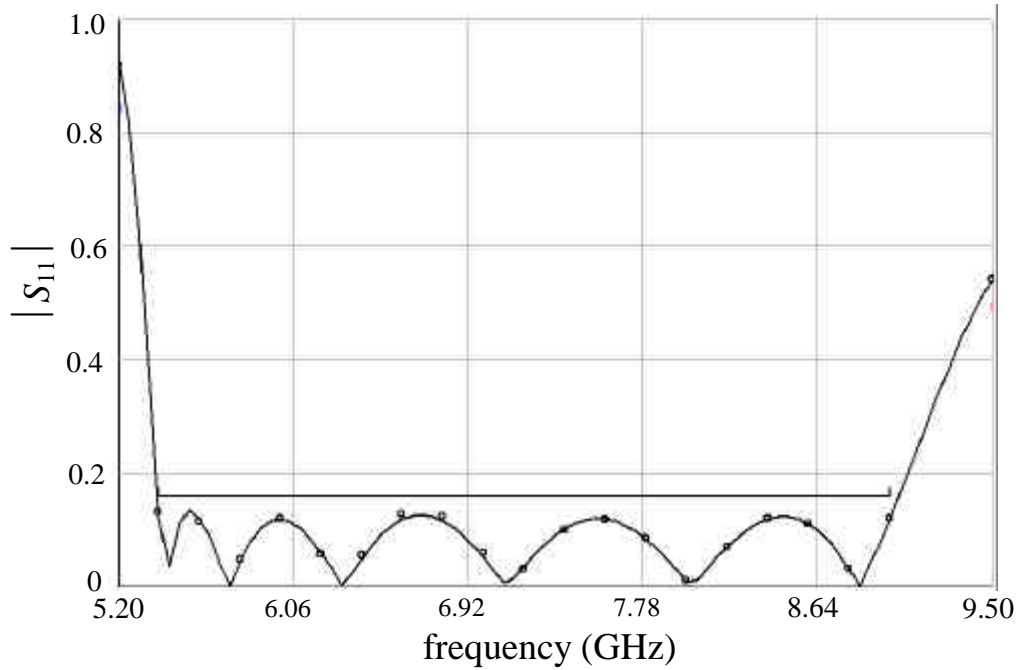

Fig. 11. The optimal coarse model response (—) and the optimal minimax fine model response (o) for the six-section waveguide filter.