Tuneable and Dual-Band MSAs

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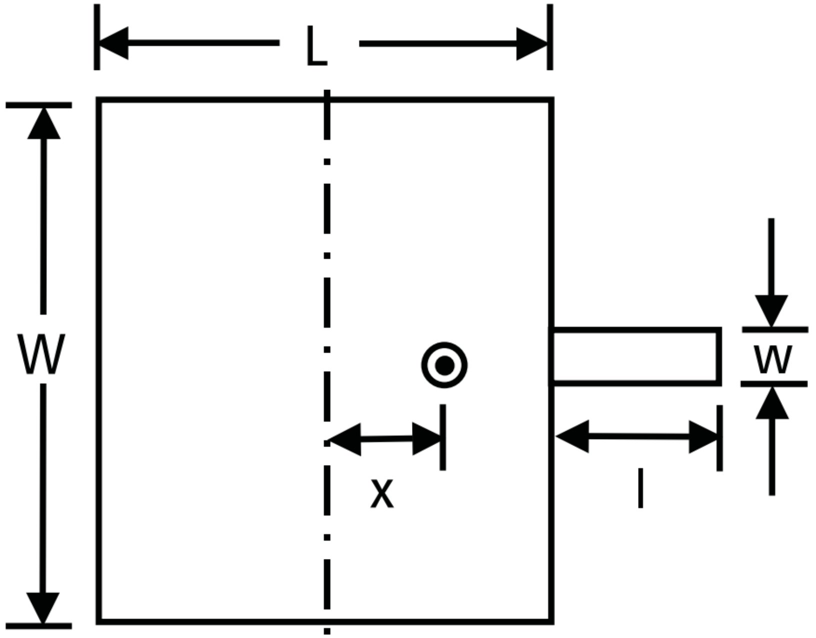
Tuneable RMSA with a Single Stub



$$\boxed{f_0 \approx \frac{c}{2(L_e + \Delta l_1)\sqrt{\epsilon_e}}}$$

where

$$\Delta l_1 = w_e \cdot l_e / W_e$$

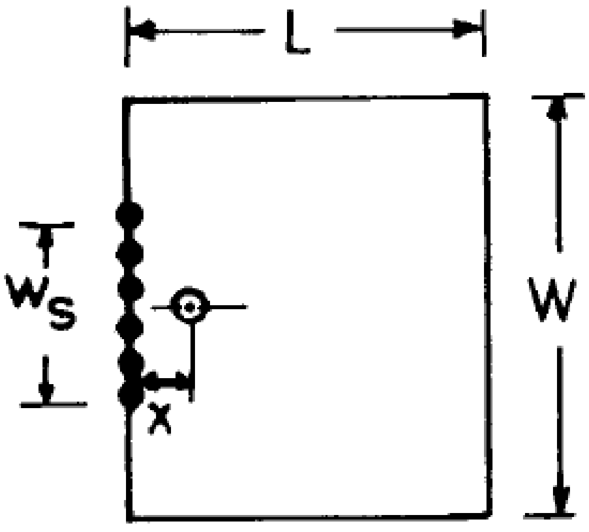
Instead of adding stub, notch can be cut along radiating or non-radiating edges for frequency tuning

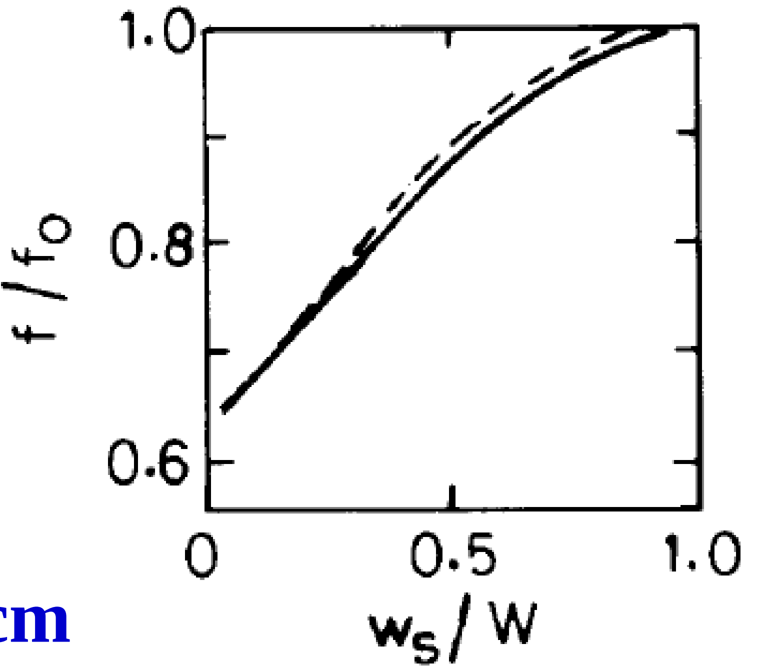
Effect of Stub on Frequency and BW of a Single Stub Loaded RMSA

(L = 3 cm, W = 4 cm, x = 0.7 cm, ε_r = 2.55, h = 0.159 cm and tanδ = 0.001)

l (cm)	*w* (cm)	f_o (GHz)	BW (MHz)
0.0	0.0	2.975	65
0.5	0.4	2.898	60
1.0	0.4	2.740	49
1.0	0.2	2.828	55
1.5	0.4	2.434, 3.377	23, 33

Tuneable RMSA using Shorting Post





L = 1.2 cm, W = 1.2 cm

x = 0.155 cm,

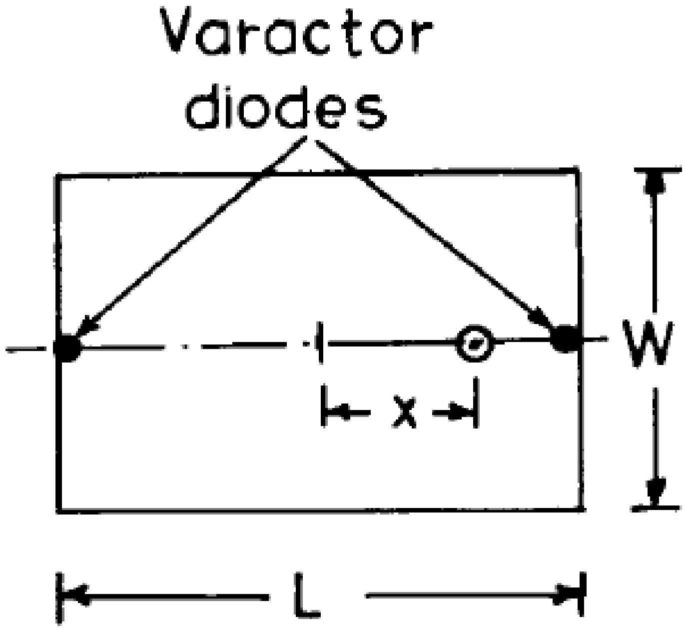
ε_r = 2.55 and h = 0.12 cm

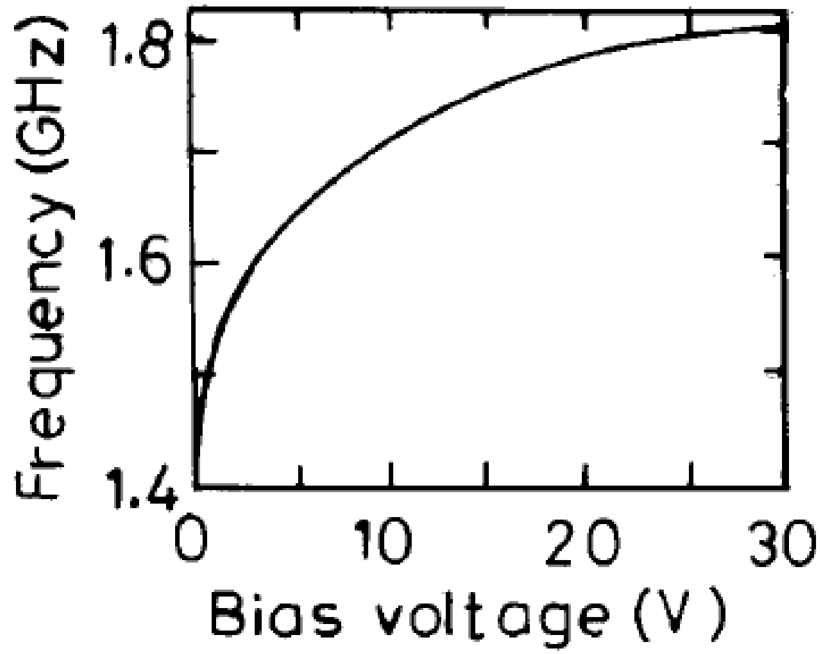
(- - -) theoretical

(——) measured

As the shorting ratio decreases from 1.0 to 0.1, the normalized resonance frequency decreases from 1.0 to 0.65

Tuneable RMSA using Varactor Diodes

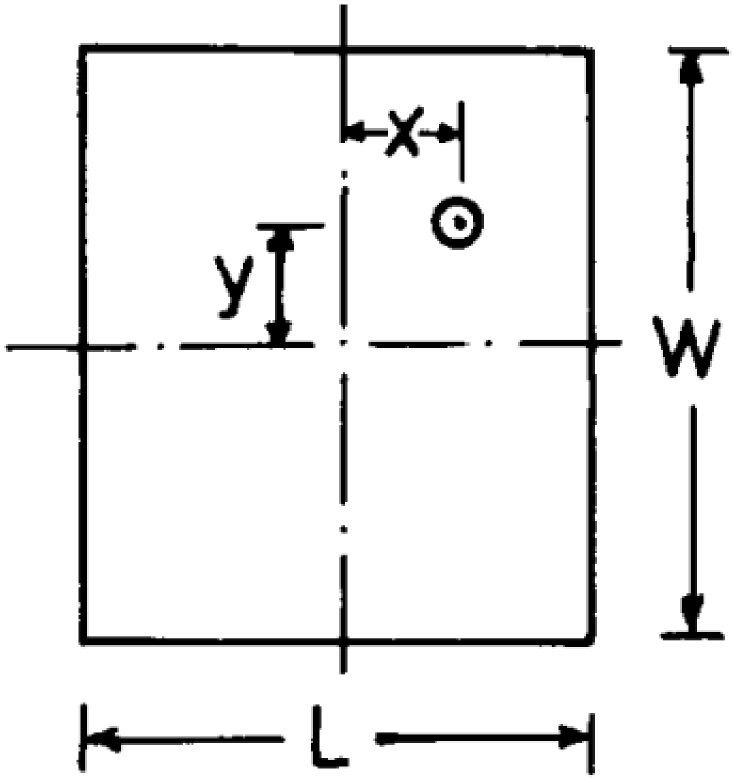




L = 4.65 cm, W = 3.0 cm and x = 1.7 cm

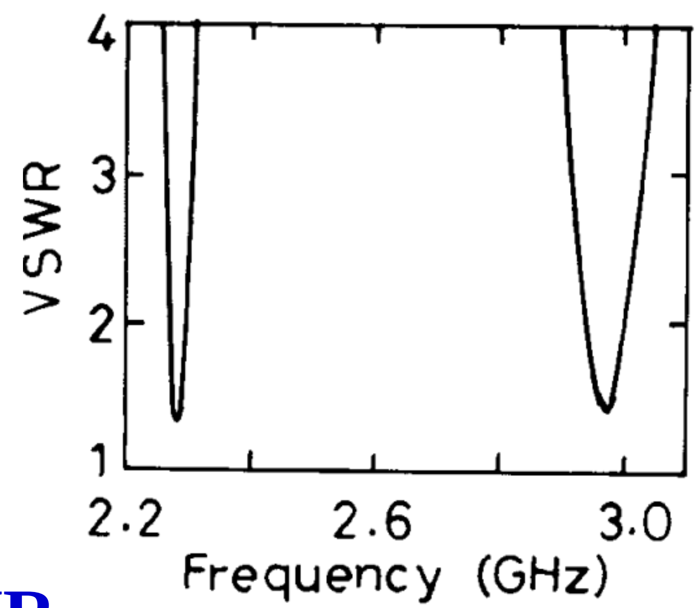
As the bias voltage increases from 0 to 30 V, the measured resonance frequency increases from 1.40 GHz to 1.81 GHz (tuning range of ~ 25%)

Single Feed Dual-Band RMSA



(a)

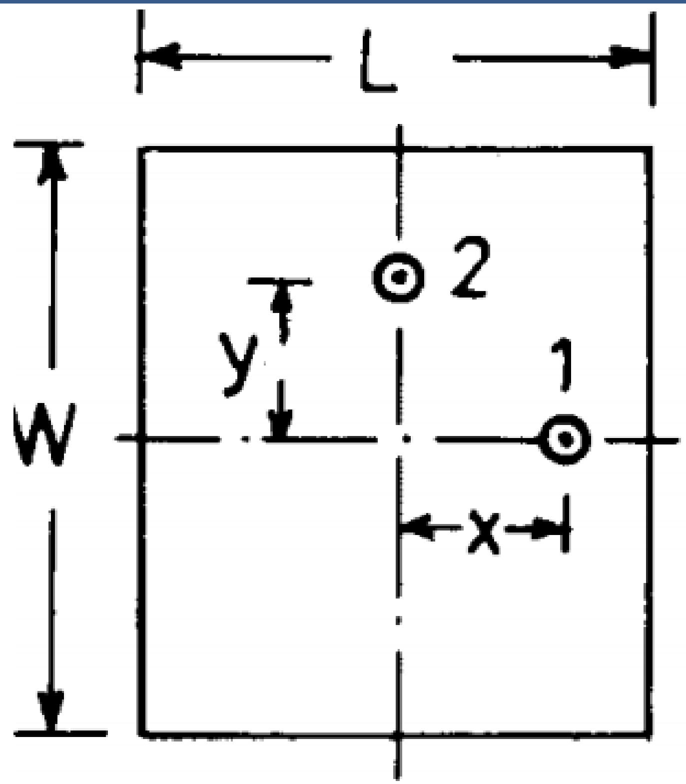
L = 3.0 cm, W = 4.0 cm
x = 0.7 cm, y = 0.5 cm
ε_r = 2.55, h = 0.159 cm,
and tanδ = 0.001



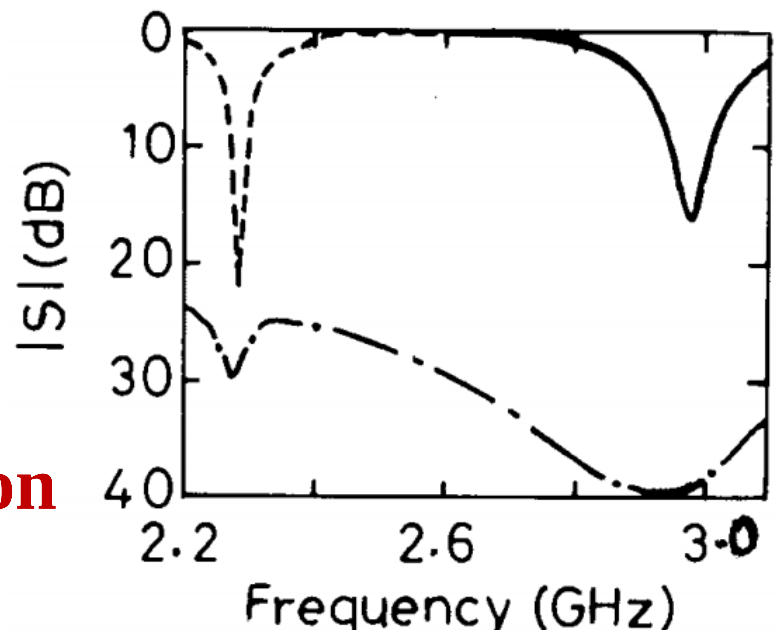
(b)

(a) RMSA with a single feed for dual band orthogonal polarization and its (b) VSWR

Dual Feed Dual Band RMSA

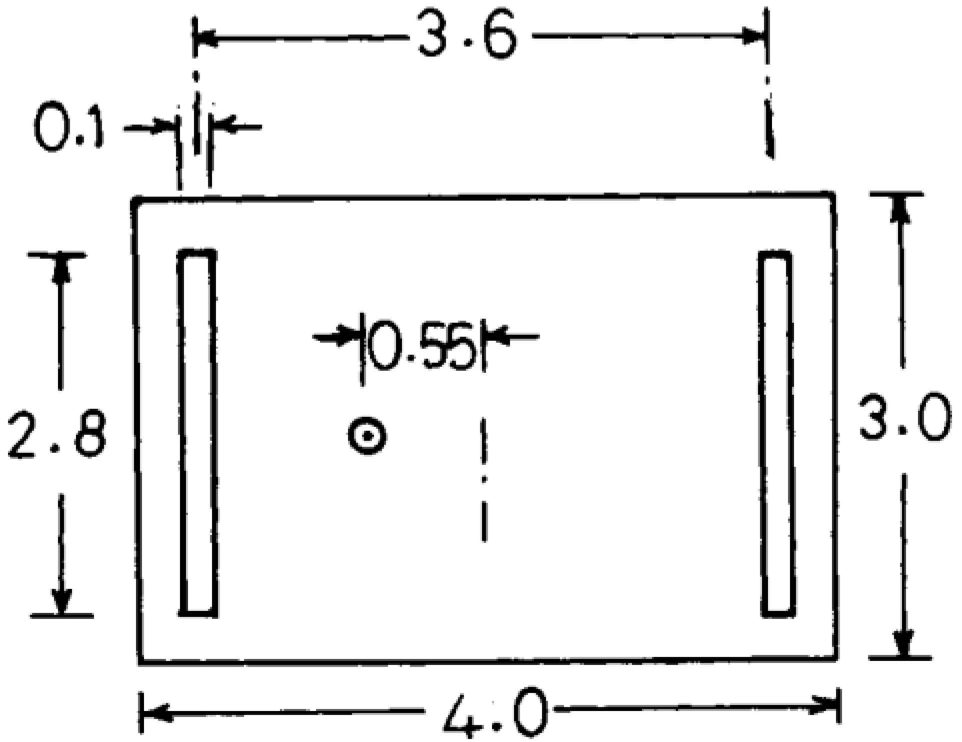


L = 3.0 cm, W = 4.0 cm
x = 0.7 cm, y = 0.5 cm
ε_r = 2.55, h = 0.159 cm,
and tanδ = 0.001



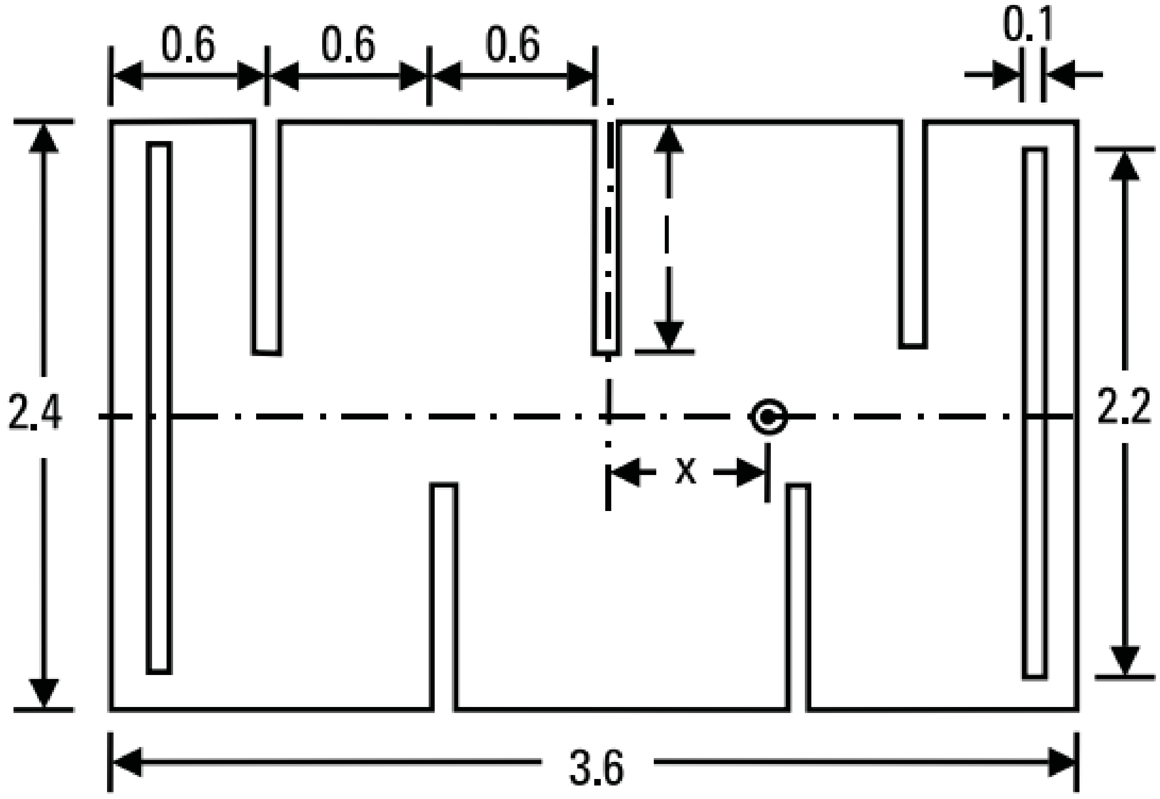
RMSA with two orthogonal feeds for dual-band operation and its S-parameters:
(—) S_{11}, (---) S_{22}, and (–.–) S_{21}

Dual Band Slotted RMSA



By changing slot dimensions and position, current distributions for the TM_{10} and TM_{30} modes change. For ε_r = 2.2 and h = 0.08 cm, dual-frequency operation is obtained at 2.22 and 3.48 GHz (frequency ratio = 1.57), which is < 3 for the RMSA without slots.
Radiation pattern is in broadside direction at both frequencies.

Compact RMSA with Multiple Slits for Dual Band Operation

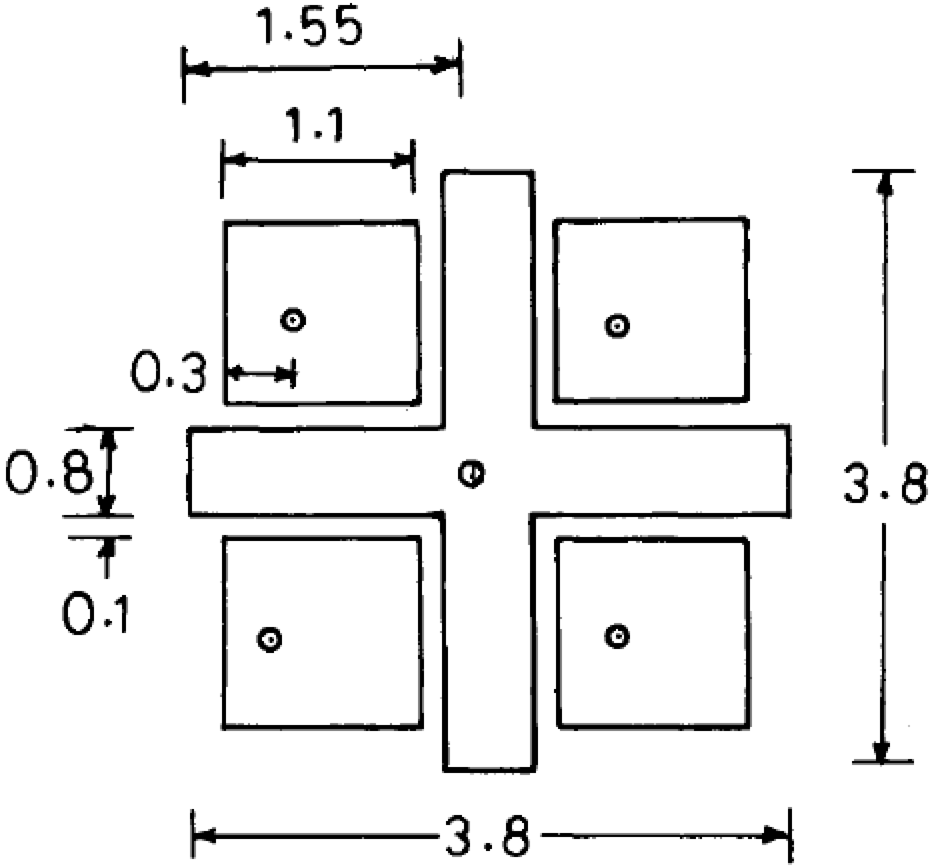


Slits along the non radiating edges increase the surface current path for TM_{10} and TM_{30} modes, leading to reduction in the resonance frequency.

Effect of Slit Length on Two Frequencies of Compact RMSA with Multiple Slits

l (cm)	*x* (cm)	Lower resonance		Upper resonance		f_2 / f_1
		f_1 (GHz)	BW(%)	f_2 (GHz)	BW(%)	
0.0	0.67	1.915	1.78	3.620	1.19	1.89
0.4	0.63	1.811	1.60	3.620	1.16	2.00
0.6	0.59	1.698	1.53	3.531	1.13	2.08
0.8	0.50	1.553	1.48	3.318	1.12	2.14
1.0	0.50	1.390	1.37	3.062	1.08	2.21
1.2	0.50	1.196	1.34	2.730	1.17	2.28
1.3	0.50	1.096	1.46	2.590	1.24	2.36

Dual Band MSA at S and X Bands



Substrate Parameters: $\varepsilon_r = 2.2$ and h = 0.08 cm.
Cross-shaped patch resonates at 2.85 GHz and four square patches operate as an array at 8.65 GHz.