

Broadband miniature quadrature coupler on planar cells

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Coupler

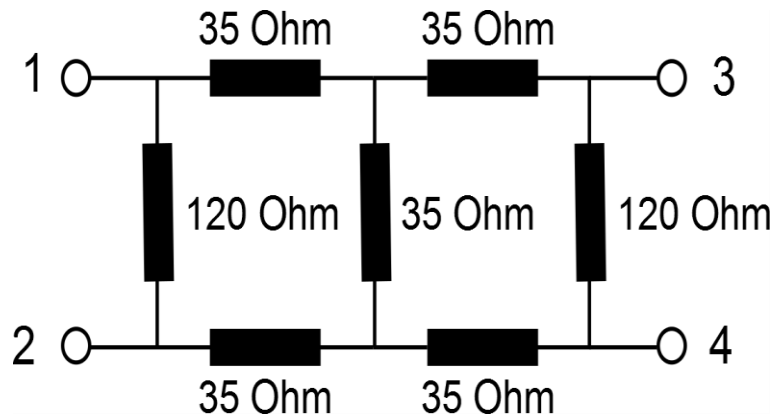


Fig. 1. Block diagram of a three-loop coupler.

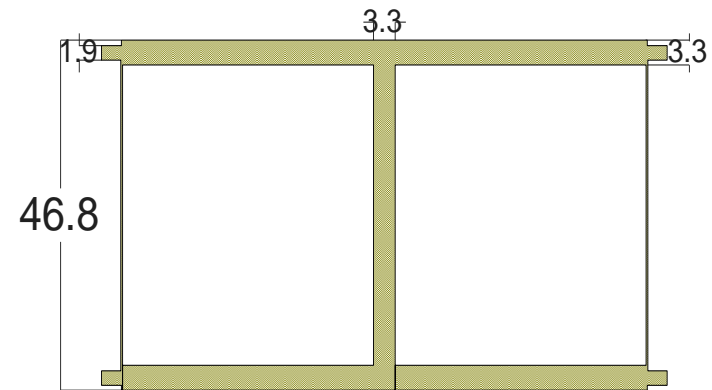


Fig. 2. The layout of the two-frequency divider in the standard version

Coupler

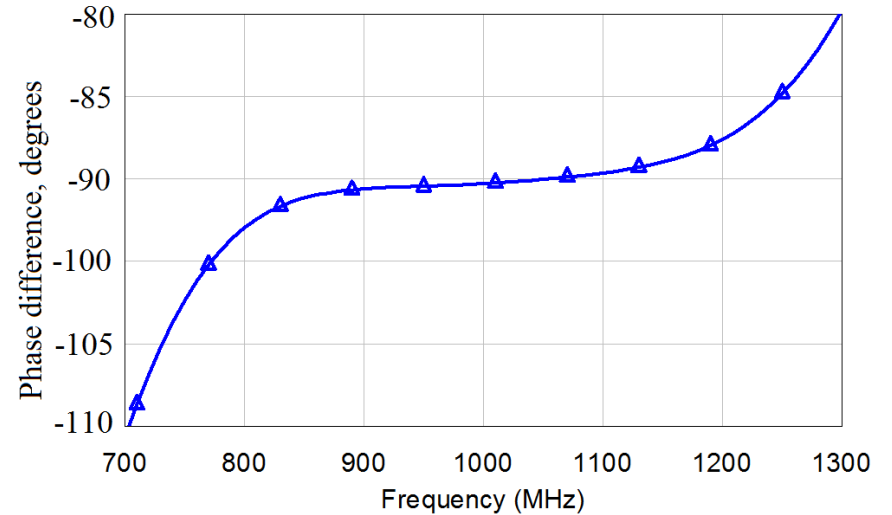
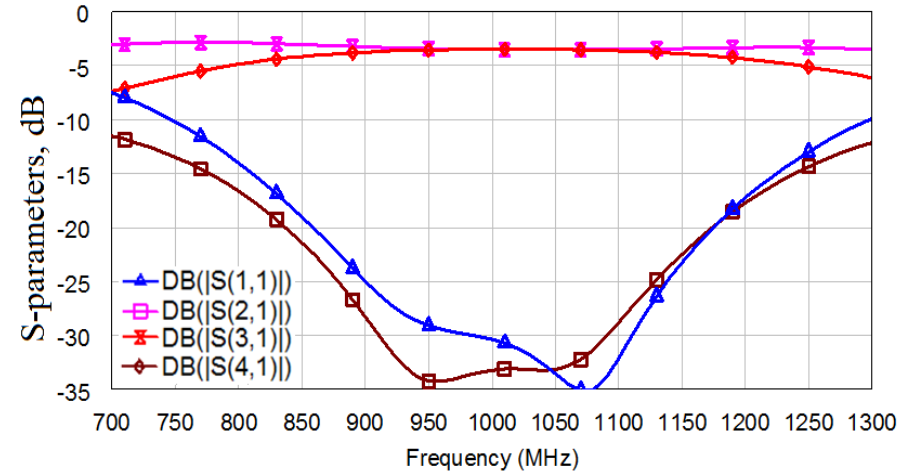
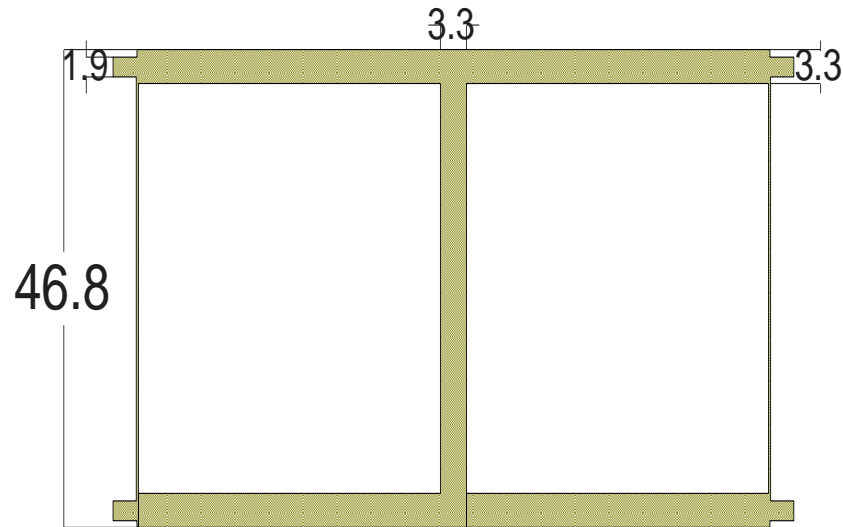


Fig. 3. Directional coupler and its characteristics

Miniaturization

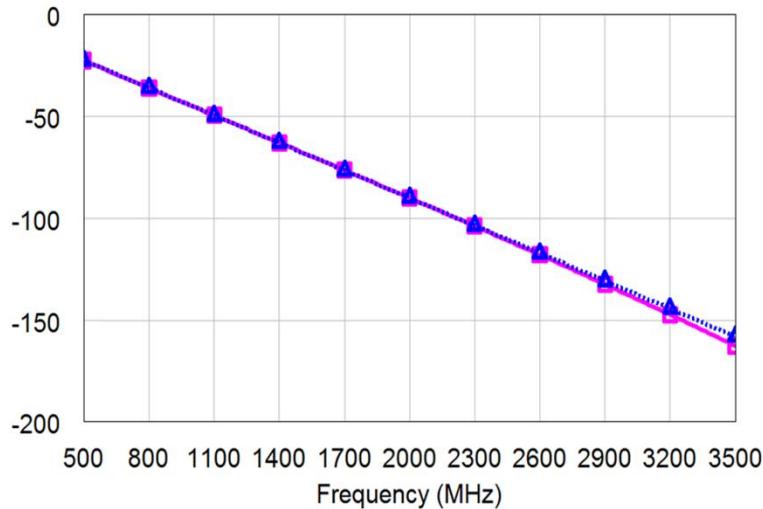
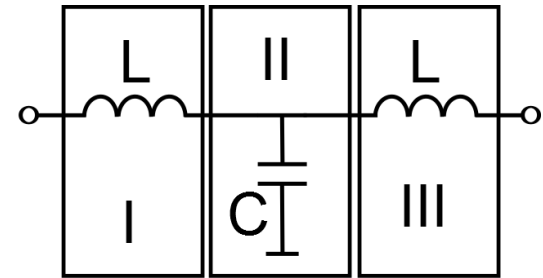


Fig. 4. Phase shifts of quarter-wave microstrip segment (dashed) and LPF (continuous)



$$[A] = \begin{bmatrix} \cos \beta l & i \sin \beta l \\ \frac{i \sin \beta l}{\rho} & \cos \beta l \end{bmatrix} \quad [A]_T = \begin{bmatrix} 1 + ZY & 2Z + YZ^2 \\ Y & 1 + ZY \end{bmatrix}$$



$$\left. \begin{aligned} L_T &= \frac{\rho}{\omega} \operatorname{tg} \left| \frac{\theta}{2} \right| \\ C_T &= \frac{1}{\omega \rho} \sin |\theta| \end{aligned} \right\} T_{cell}$$

Compact coupler

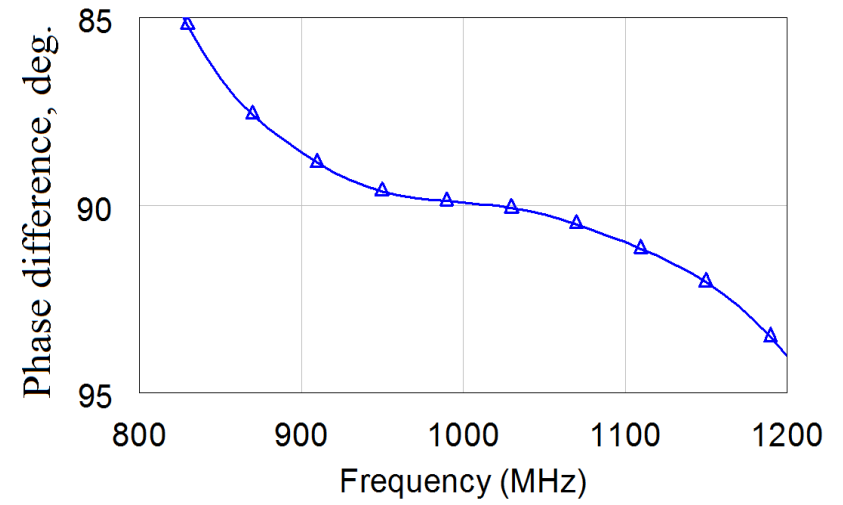
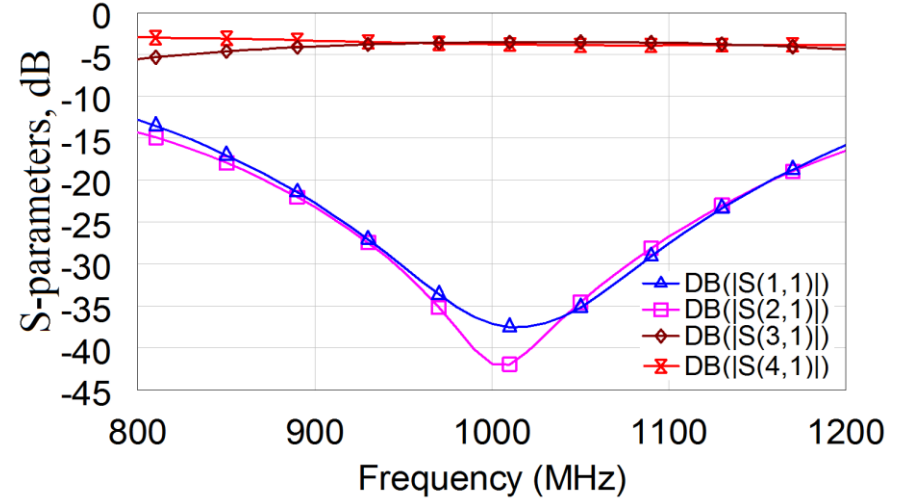
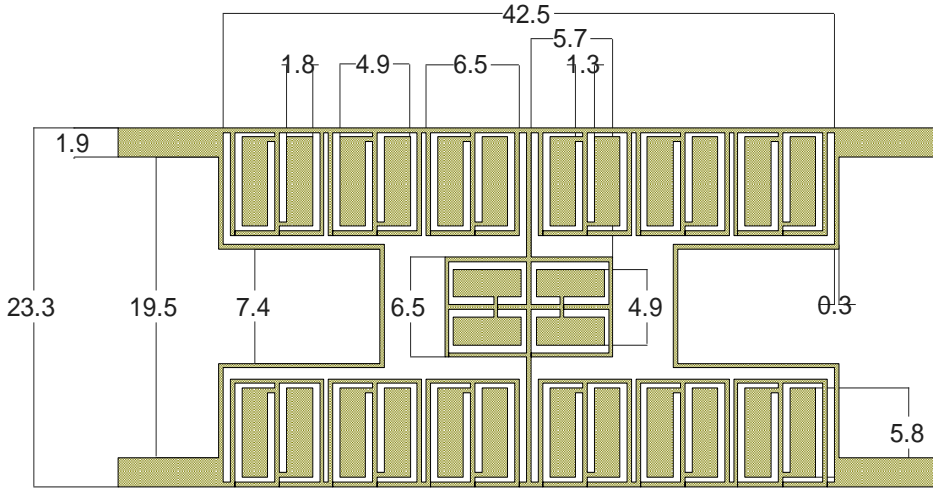


Fig. 5. Directional coupler and its characteristics

Compact coupler

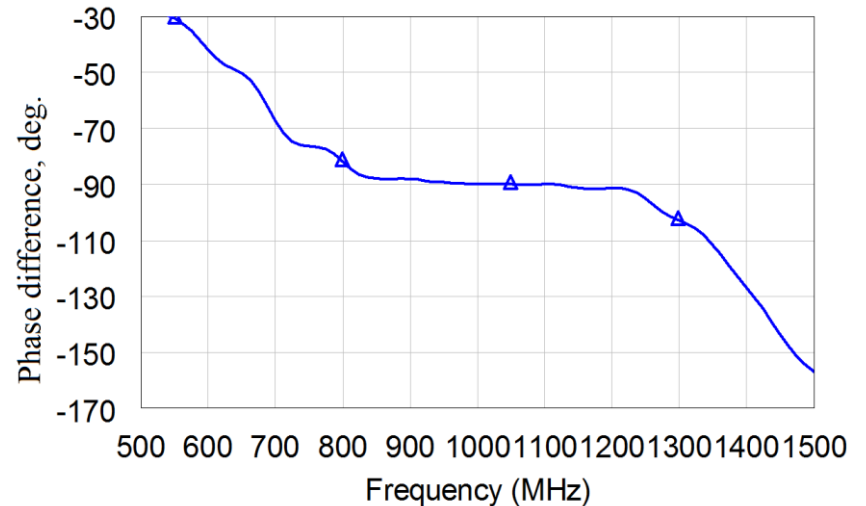
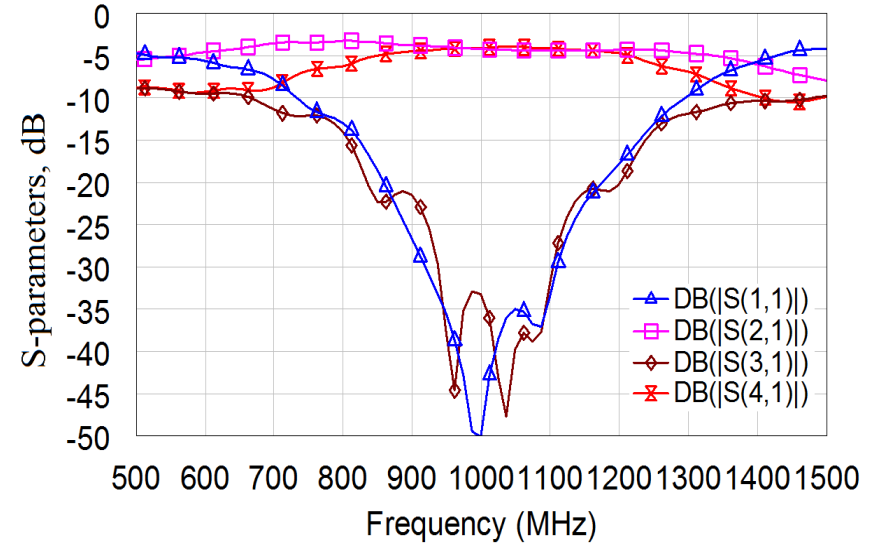
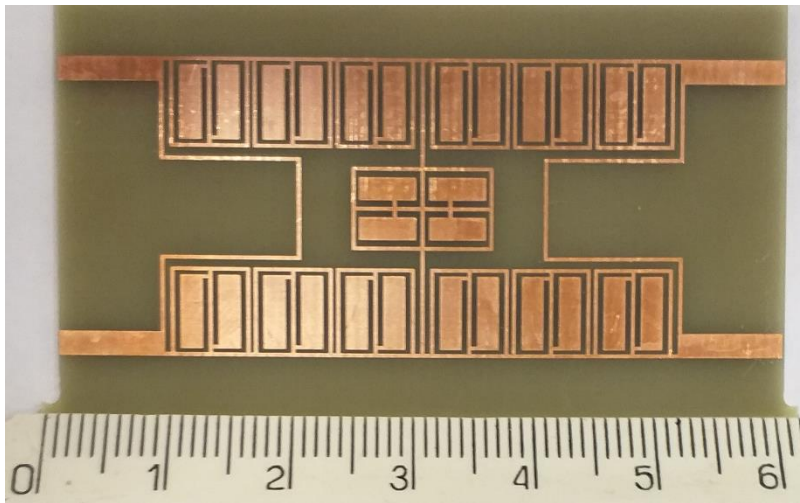


Fig. 6. Prototype and its characteristics

Compact coupler

Table 1 Comparison of traditional and compact broadband couplers

Parameters	Proposed	Conventional
Area (mm ²)	1004.2	3786
Relative size	26.5%	100%
Maximum imbalance between transmission coefficients in the frequency band	2.2	1.8
Return loss (dB)	42	30
Isolation (dB)	36	32
Phase difference	89	90
Harmonic Suppression	YES	NO

Conclusion

A compact broadband directional coupler with equal division of input power has been developed. At a center frequency of 1 GHz, the coupler has an area of 1004.2 mm², which is 73.5% less than the area of the full-size structure. However, the compact design has less bandwidth by 5%. The entire tap design process was carried out in the NI-AWR Design Environment. A model of the proposed device was made, which showed high convergence with the design results.

Thank you for attention!