# RECENT RESULTS IN ELECTROMAGNETIC OPTIMIZATION OF MICROWAVE COMPONENTS INCLUDING MICROSTRIP T-JUNCTIONS

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## Outline

we present recent advances in automated electromagnetic (EM) optimization of microwave components and circuits

we review the challenge of EM optimization and present illustrative examples

examples involve both direct optimization using commercial EM simulators and Space Mapping optimization

we review a robust new algorithm for EM optimization called TRASM (Trust Region Aggressive Space Mapping)

the trust region ensures that each iteration results in improved alignment between the coarse and fine models

recursive multi-point parameter extraction improves the conditioning of the extraction phase

we exploit Sonnet's ***em***, MATLAB, OSA90, OSA's Datapipe, interpolation and database techniques and Geometry Capture

examples include the EM optimization of microstrip T-junctions and an HTS filter

# Optimal Microstrip T-junctions

“direct” EM minimax optimization has been reported (*Bandler et al., 1993, 1994, 1997*)

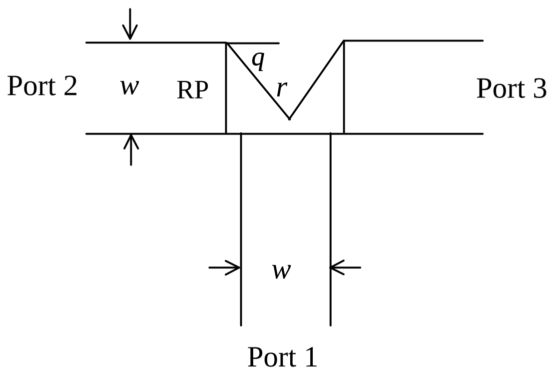
we present some new results: a comparison between different configurations to compensate discontinuity effects in T-junctions

the comparison is done by applying direct optimization to the different configurations

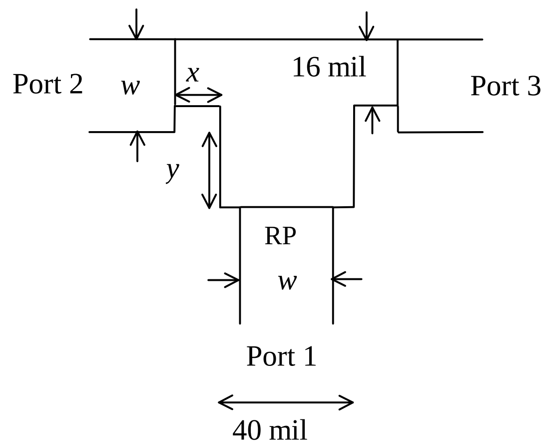
the target is to achieve the minimum possible mismatch at the three ports

the T-junction considered is symmetric and connected to 50 Ω transmission lines

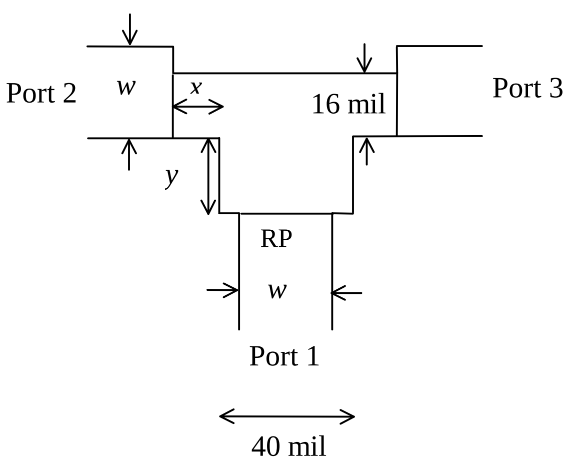
# Optimal Microstrip T-junctions



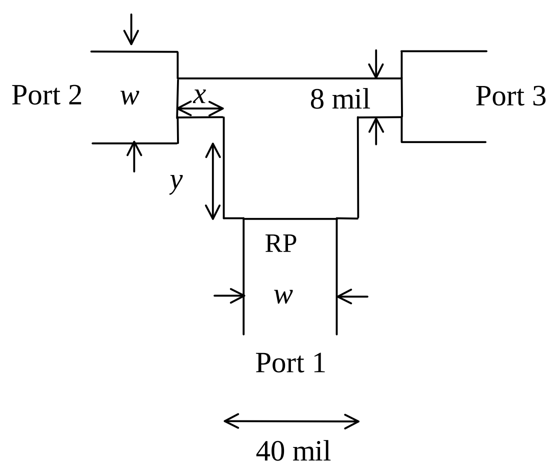

(a)
(*Gupta et al.*, 1982)




(b)
(*S. Wu et al.*, 1990)




(c)
(*Proposed here*)




(d)
(*M. Dydyk*, 1977)

$w$= 24 mil, $h$=25 mil and $e_r$ =9.9

## Design Specifications

the specifications considered here are

$$\left|S_{11}\right| \le \frac{1}{3}, \quad \left|S_{22}\right| \le \frac{1}{3},$$

in the frequency range 2 to 16 GHz

the width *w*, the height *h* and the relative dielectric constant $\epsilon_r$ are fixed during optimization

three tools are exploited: Sonnet's ***em*** simulator, the minimax optimizer in OSA90/hope and Empipe

## Optimization Results

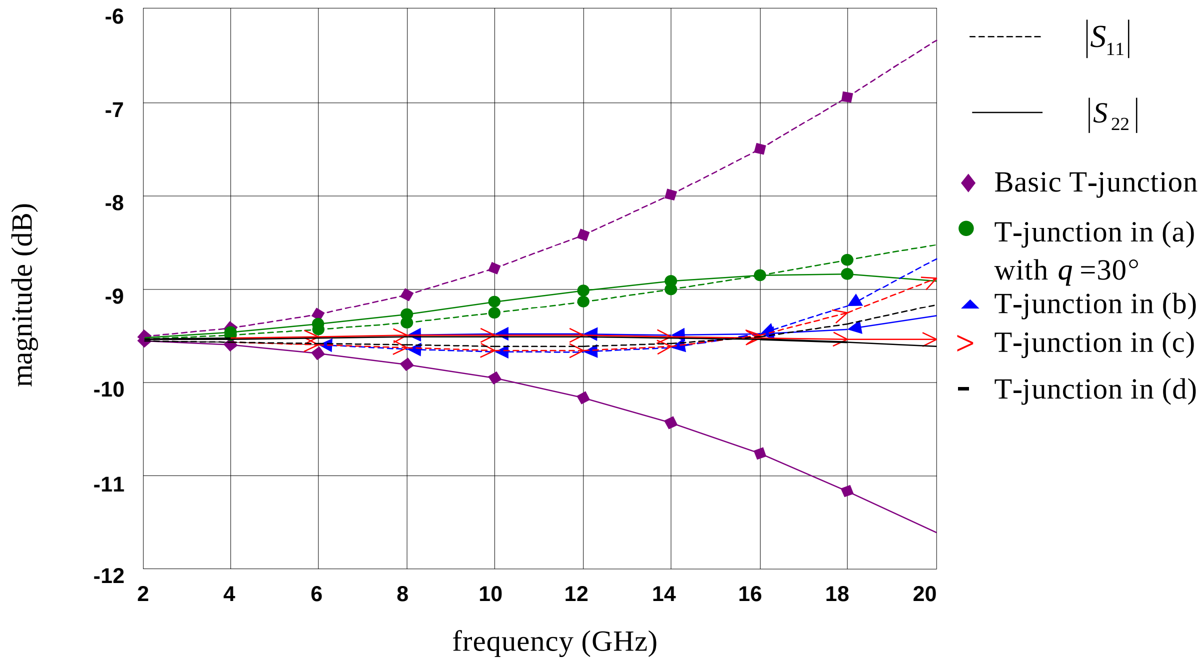
optimal value of $r$ at $q$ equal to 30°, 45° and 60°
for the T-junction in (a)

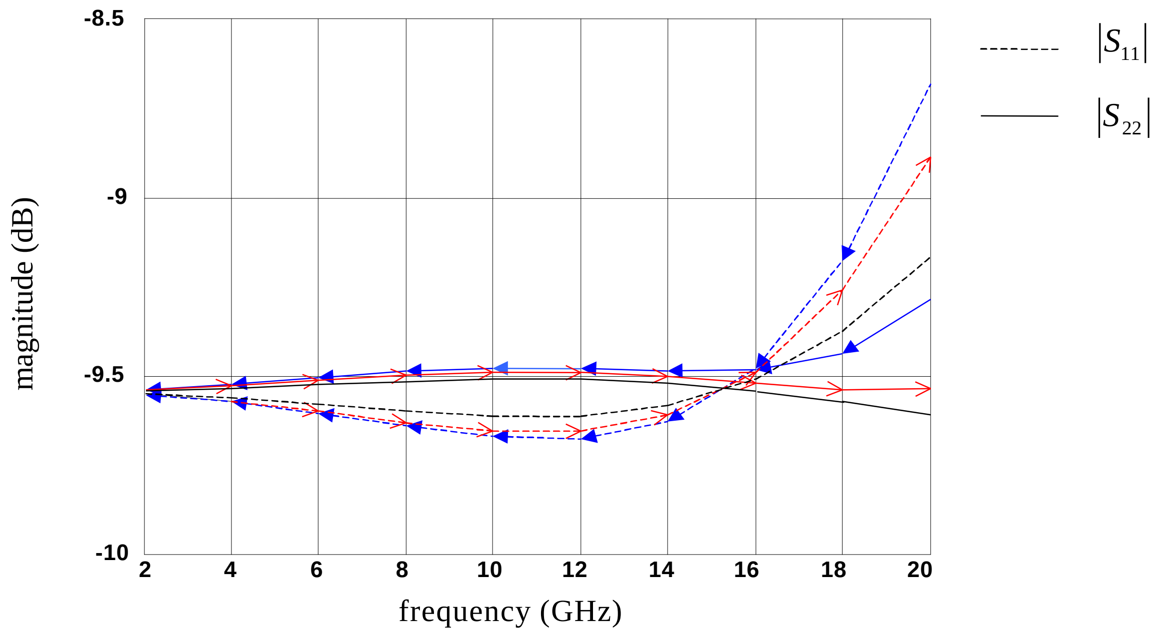
| $q$ | optimal value of $r$ |
|---|---|
| 30° | 1.556 $w$ |
| 45° | 1.355 $w$ |
| 60° | 1.158 $w$ |

optimal values of the parameters $x$ and $y$ for the
T-junctions in (b), (c) and (d)

| T-junction | optimal value of $x$ | optimal value of $y$ |
|---|---|---|
| (b) | 0.9250 $w$ | 0.583 $w$ |
| (c) | 0.7271 $w$ | 0.7917 $w$ |
| (d) | 0.1 $w$ | 0.9167 $w$ |

# Optimization Results



## Discussion on the T-junctions

the T-junction in (a) with $q$ equal to 30° gives unsatisfactory results since $|S_{11}|$ and $|S_{22}|$ are far from the ideal –9.54 dB

the T-junctions in (b), (c) and (d) give satisfactory results with minor response differences

**Conclusions**

advances in computational electromagnetics and optimization technology allow direct exploitation of CPU intensive EM simulation techniques in circuit design optimization

Space Mapping is a powerful approach for extremely CPU intensive simulators, combining the speed of circuit-level optimization with the accuracy of EM simulations

we reviewed TRASM, a new algorithm for EM optimization

examples include EM optimization of microstrip T-junctions and an HTS filter

we compared four configurations to compensate discontinuities in a T-junction

a new configuration has been introduced

the HTS filter is particularly challenging: narrow bandwidth (about 1.24 %) and high dielectric constant (about 24)

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