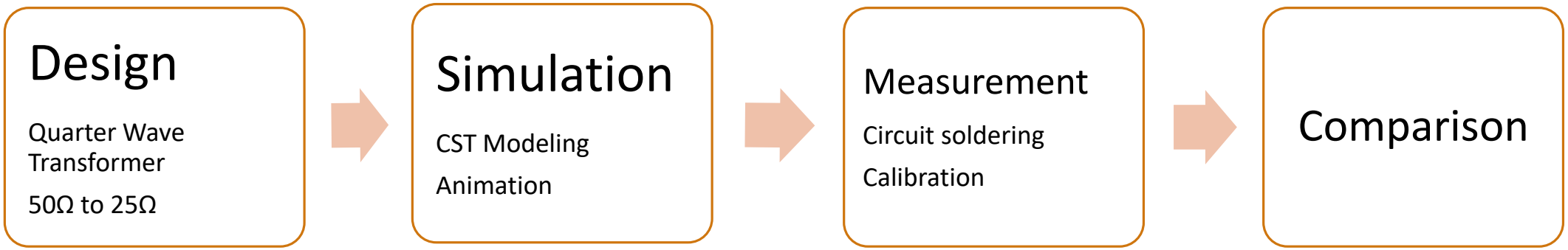
50Ω to 25Ω Microstrip Lines Design and Simulation

JIAWEI ZHANG, ELENA CHONG, LINGTONGYUE JIN

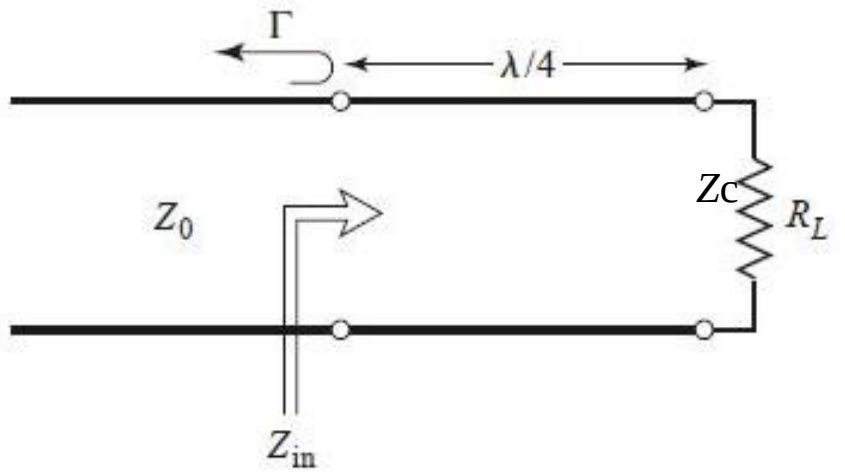
Overview


Design
Quarter Wave Transformer
50Ω to 25Ω
Simulation
CST Modeling
Animation
Measurement
Circuit soldering
Calibration
Comparison

Quarter Wave Transformer

Impedance of Quarter-wave

$$Z_{\text{in}} = \frac{Z_c^2}{R_L}, \quad Z_c = \sqrt{Z_{\text{in}} R_L} \qquad (2.62)$$



Length of Quarter-wave

$$v = \frac{1}{\sqrt{\varepsilon \cdot \mu}} = \frac{3 \cdot 10^8}{\sqrt{\varepsilon_r}} \frac{m}{s}$$

ε_r → Effective permittivity

$$\lambda/4 = \frac{1}{4} \frac{v}{f}$$

$$Z_{\text{in}} = Z_0 \;, \quad \Gamma = 0$$

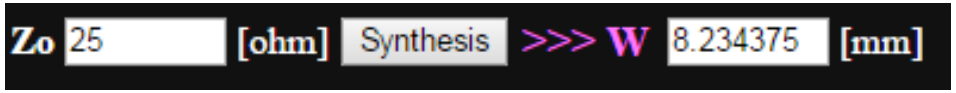
Microstrip Lines Width Calculation

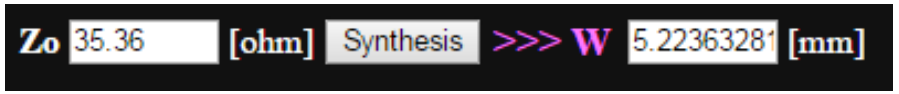
Equations from Pozar

$$\epsilon_e = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \frac{1}{\sqrt{(1 + 12d/W}} \qquad (3.195)$$

$$Z_0 = \frac{120\,\pi}{\sqrt{\epsilon_e}\left[\frac{W}{d} + 1.393 + 0.667 \ln\left(\frac{W}{d} + 1.444\right)\right]} \quad \textit{for } W/d \geq 1 \qquad (3.196)$$

Lines	Width (mm)
25Ω Line	8.375
λ/4Transformer	5.360
50Ω Line	3.277



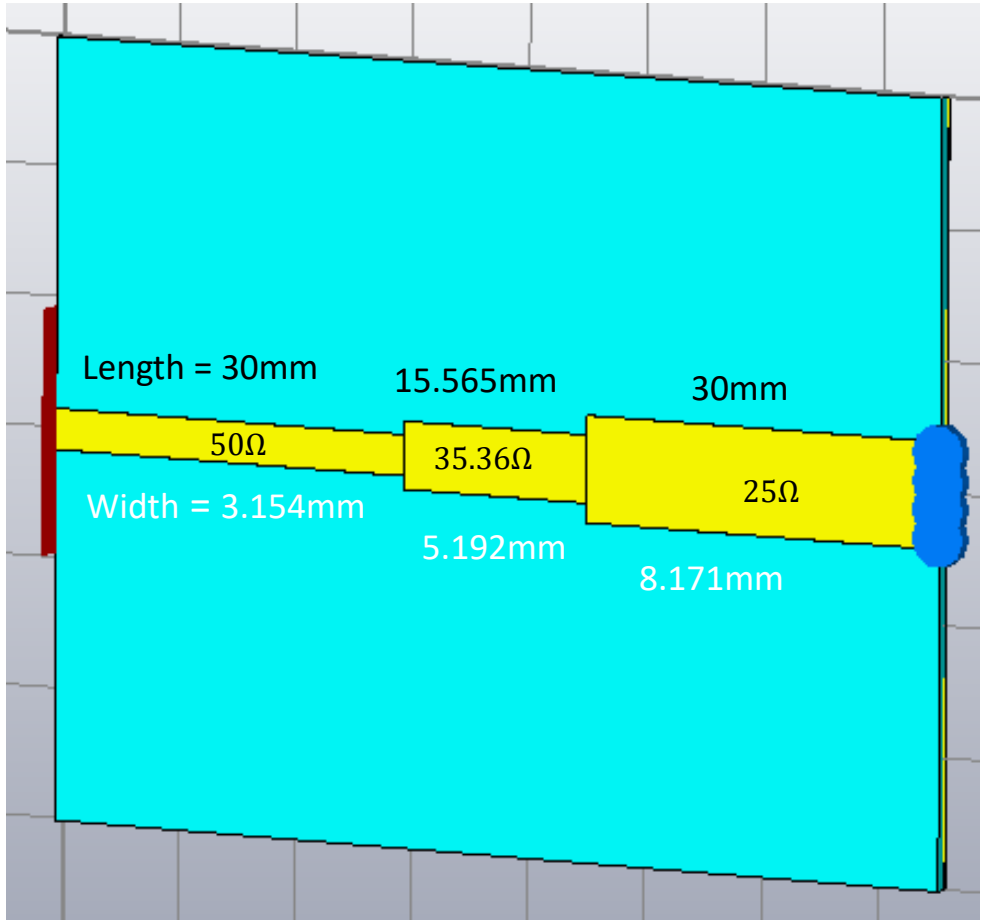


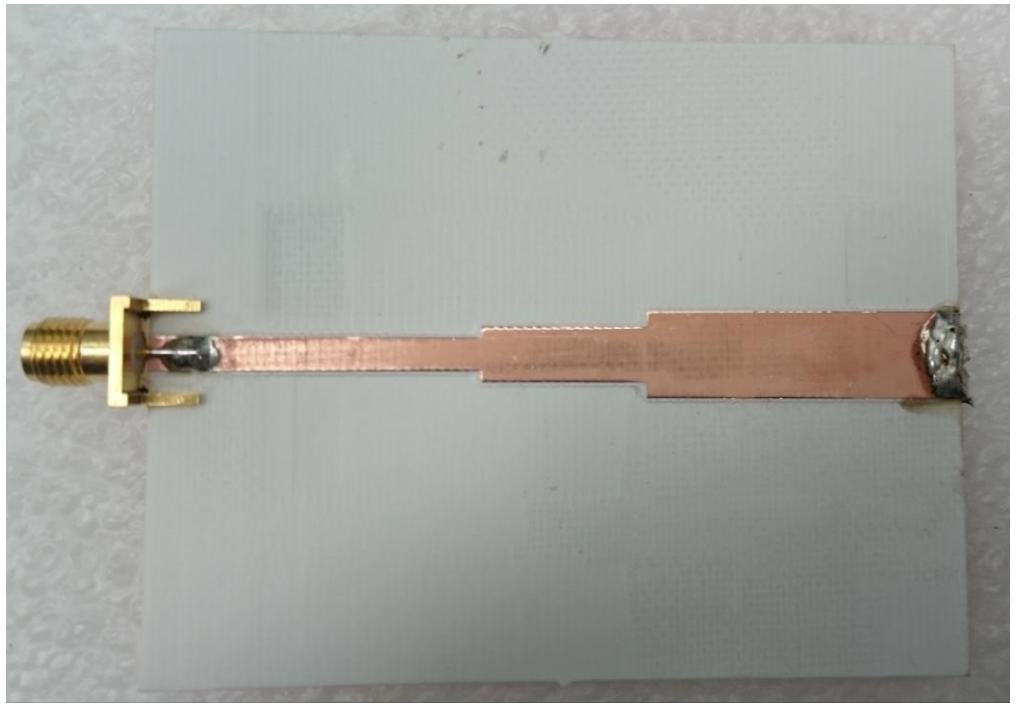
$$d = 1.160mm$$
$$\epsilon_r = 2.55$$

Verification from http://www1.sphere.ne.jp/i-lab/ilab/tool/ms_line_e.htm

Design Modeling & Building

$d = 1.160mm \quad \epsilon_r = 2.55$





Preparing for measurement

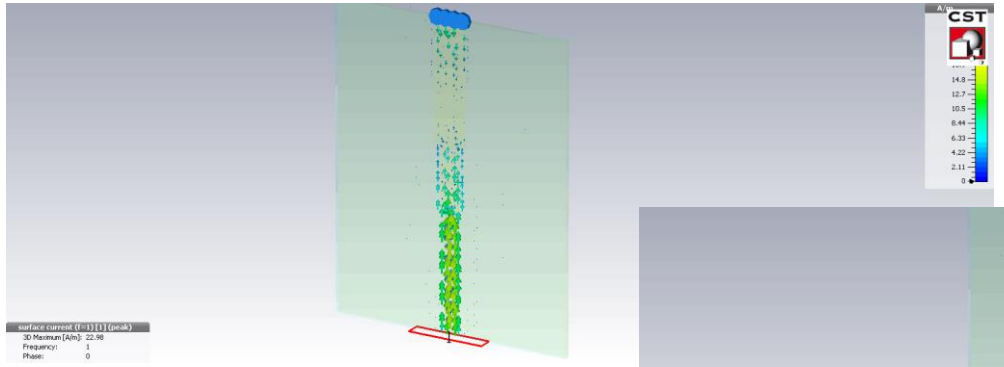
Calibrating the Vector Network Analyzer

Short-Open-Load Calibration

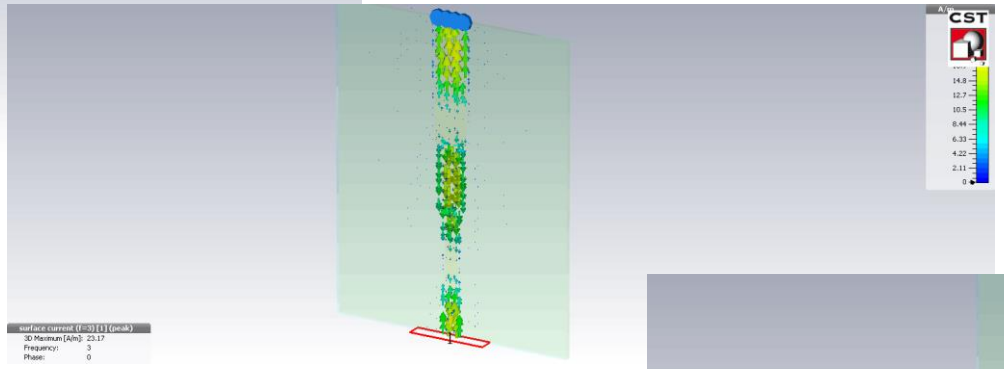
3.5mm Calibration Kit

CST Simulation

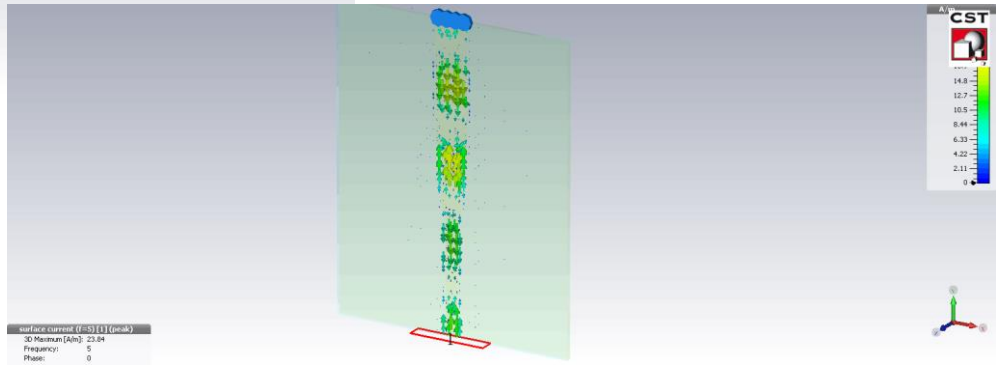
Animations in Frequency Domain



@ 1GHz



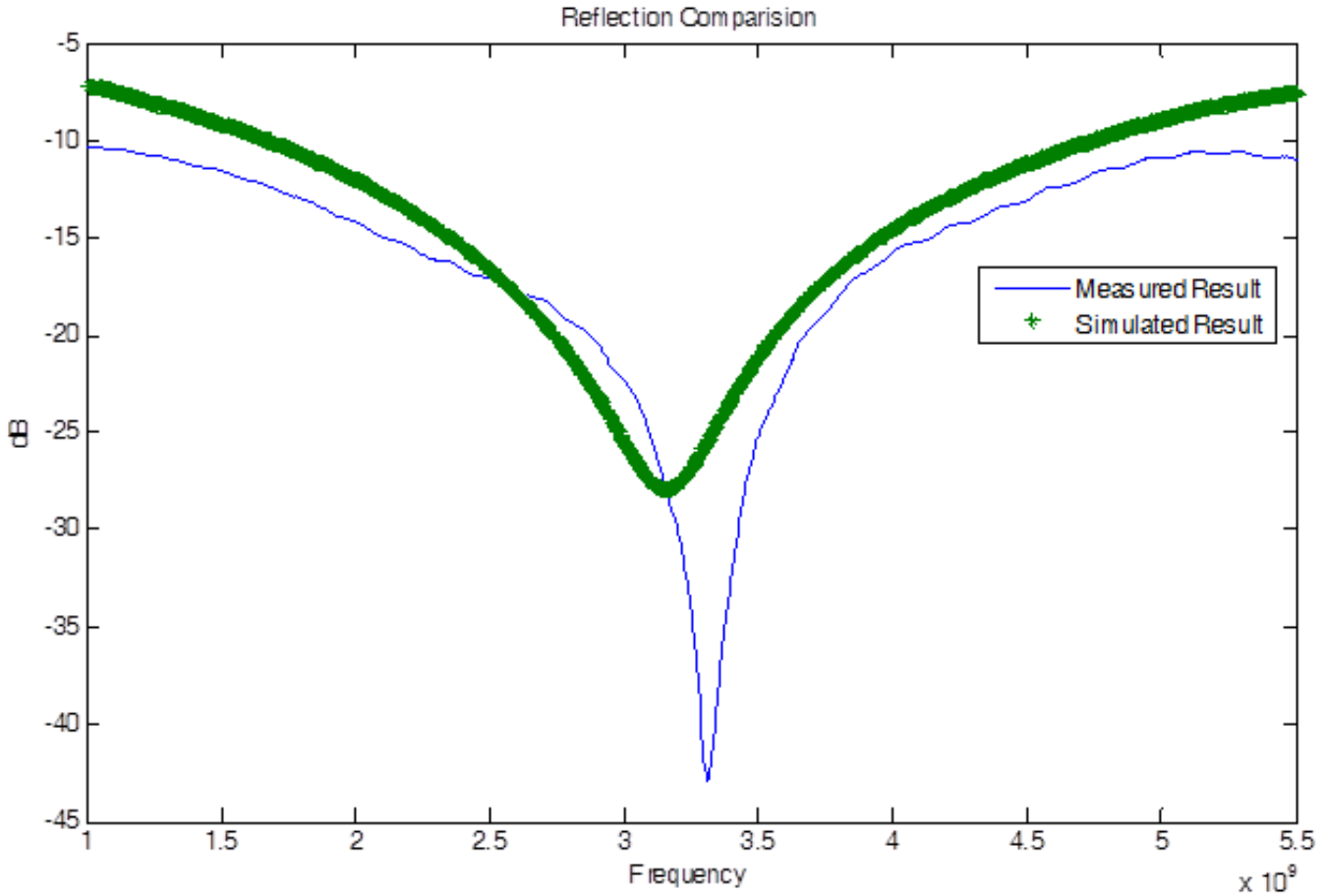
@ 3GHz



@ 5GHz

Results Comparison

Measurement & Simulation



Citations

[1] David M. Pozar, *Microwave Engineering.* Hoboken: John Wiley & Sons, Inc, 2011.

[2] Stuart M. Wentworth, *Applied Electromagnetics: Early Transmission Lines Approach.* Hoboken: John Wiley & Sons, Inc, 2006.

[3] “Microstrip Line Calculator.” *InfoSphere.* [Online]. Available: *http://www1.sphere.ne.jp/i-lab/ilab/tool/ms_line_e.htm*

Questions?