

Microwave filter

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Slot: F1

Subject: Microwave Engineering

OBJECTIVE

1. For the given filter specifications, design and simulate the LPFs using Richard's Transformation and Stepped Impedance methods
2. Implement on standard substrate $\epsilon_r = 4.4$, $H = 1.6$ mm, $T = 0.05$ mm, $\tan\delta = 0.001$. System Impedance (Ohm) = 30
3. Given $Z_0 = 45$ Ohm
4. F-cutoff = 4.5 GHz
5. Insertion-loss = -30 dB at 8 GHz
6. Ripple magnitude = 0 (maximally flat)
7. Low Impedance = 35 Ohm
8. High Impedance = 125 Ohm

Procedure

Richard's Transformation

1. Find value of N for corresponding ripple factor
2. Simplify the circuit to open circuit configuration using kurdos identity.
3. Create a schematic for the following circuit.
4. Run a frequency analysis.
5. Plot the graph.

Stepped impedance method

1. Find value of N for corresponding ripple factor
2. Simplify the circuit using respective values of low impedance and high impedance.
3. Create a schematic for the following circuit.
4. Run a frequency analysis.
5. Plot the graph.

Calculations

low pass filter implementation

Given: $Z_0 = 45\Omega$
 $f_c = 1.5\text{GHz}$
 $IL = -30\text{dB}$ at 8GHz (f)
 $R = 0$
 $Z_{\text{load}} = 35\Omega$
 $Z_{\text{high}} = 125\Omega$

Task: i) Simulate LPF with open stubs (emur simulation)
 ii) Stepped Impedance Method

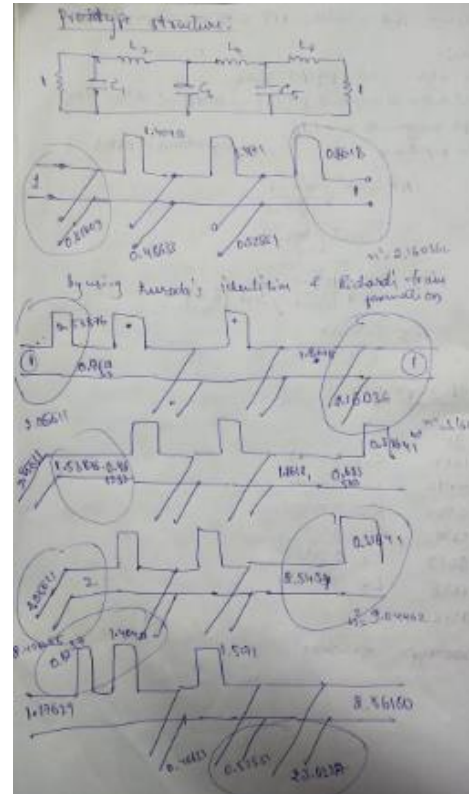
$$N \geq \frac{\log_{10}(10^{IL/10} - 1)}{2 \log_{10}(\omega/\omega_c)}$$

$$\approx \frac{\log_{10}(10^3 - 1)}{2 \log_{10}(8/4.5)}$$

$$N \approx 6.0020$$

Thus g_i

$g_1 = 0.5176 = C_1$
$g_2 = 1.9142 = L_1$
$g_3 = 1.9318 = C_2$
$g_4 = 1.9318 = L_2$
$g_5 = 1.9142 = C_3$
$g_6 = 0.5176 = L_3$



Calculations

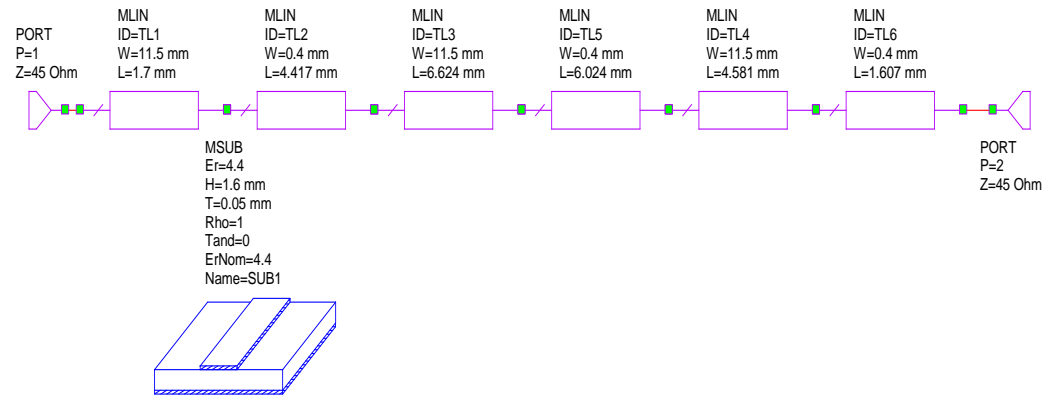
Finally calculated w & L values

w	11.5mm	L	1.7mm
w	0.9mm	L	4.917mm
w	11.5mm	L	6.624mm
w	0.4mm	L	6.074mm
w	11.5mm	L	9.581mm
w	0.9mm	L	1.607mm

Stepped impedance

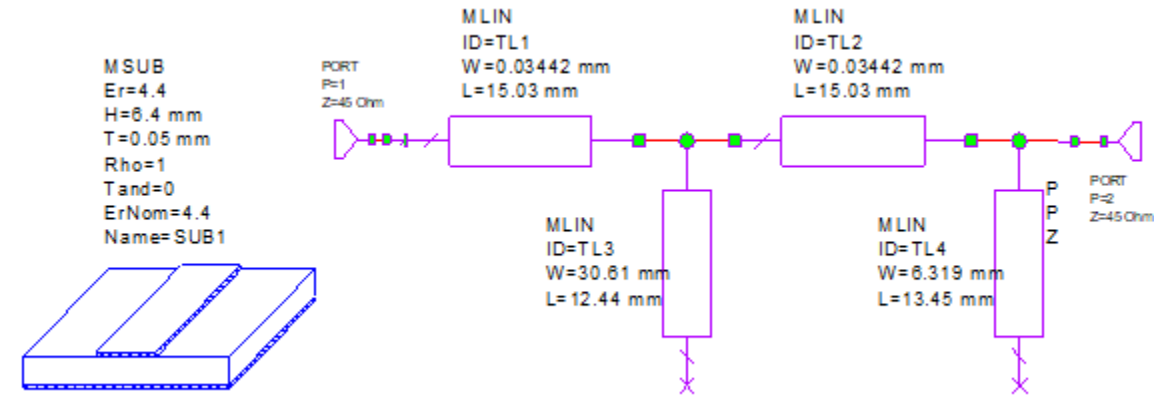
	g_i	Z_i/Z_n	pk values
1.	L	35	20.65
2.	C	125	35.20
3.	L	35	55.55 77.525
4.	C	125	48.02
5.	L	35	56.7
6.	C	125	12.81

Design



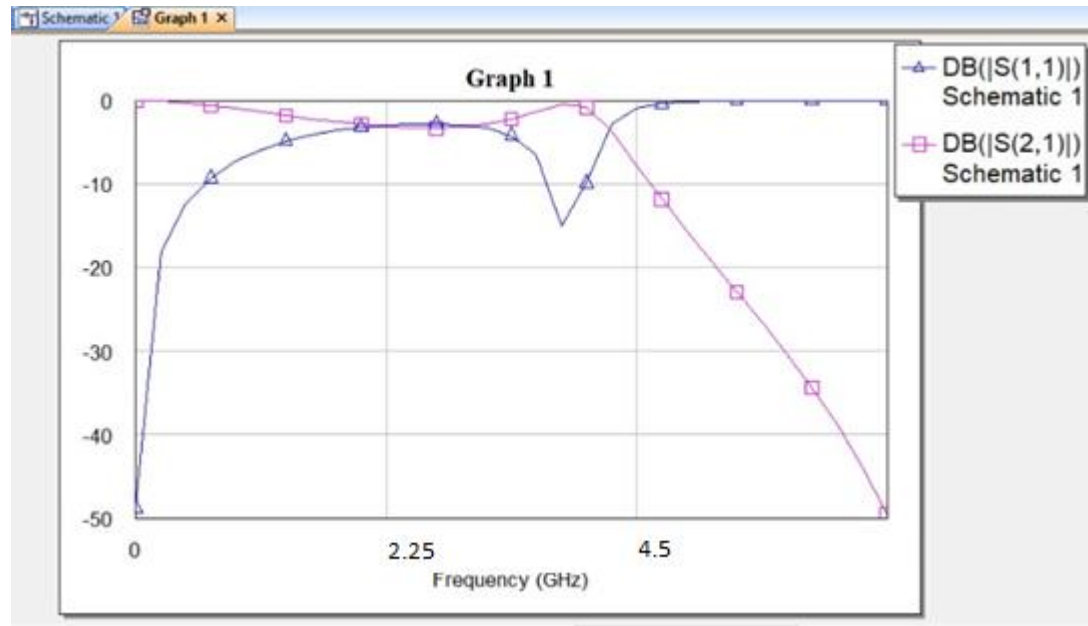
Richard's
Transformation

Stepped impedance
method

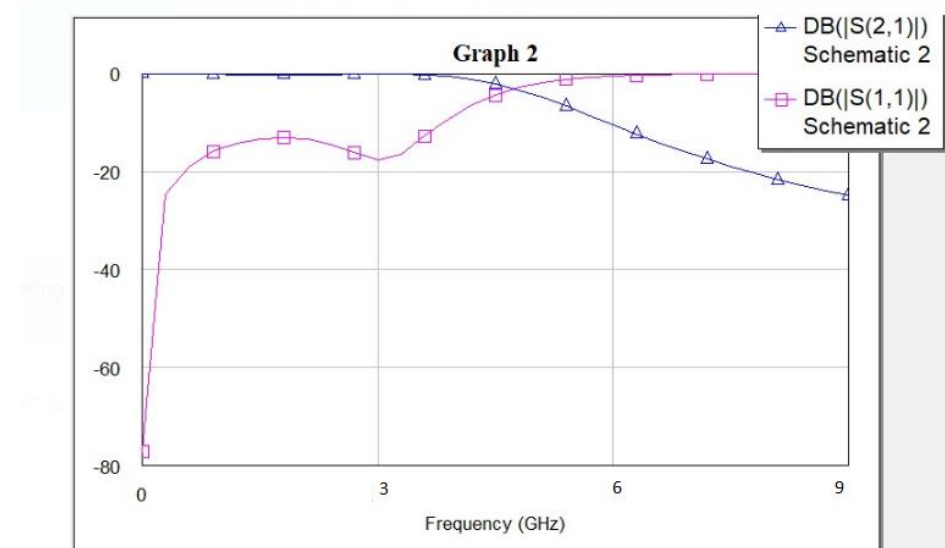


Graph

Richard's
Transformation



Stepped impedance
method



Results

- $N=6$
- $F_c=4.5\text{Ghz}$

Richard's Transformation

- $N=6$
- $F_c=4.5\text{Ghz}$

Stepped impedance method

Inferences

The Low pass filter has been designed using Richard's transformation and Step impedance method.

The graphs have been constructed and the output values have been recorded.

References

- Microwave Engineering- David M. Pozar
- https://www.tutorialspoint.com/microwave_engineering/microwave_engineering_introduction.htm
- <https://www.microwaves101.com/encyclopedias/waveguide-mathematics>
- [https://en.wikipedia.org › wiki › Microwave_engineering](https://en.wikipedia.org/wiki/Microwave_engineering)