

滤波器系列4

——阶跃阻抗低通滤波器设计

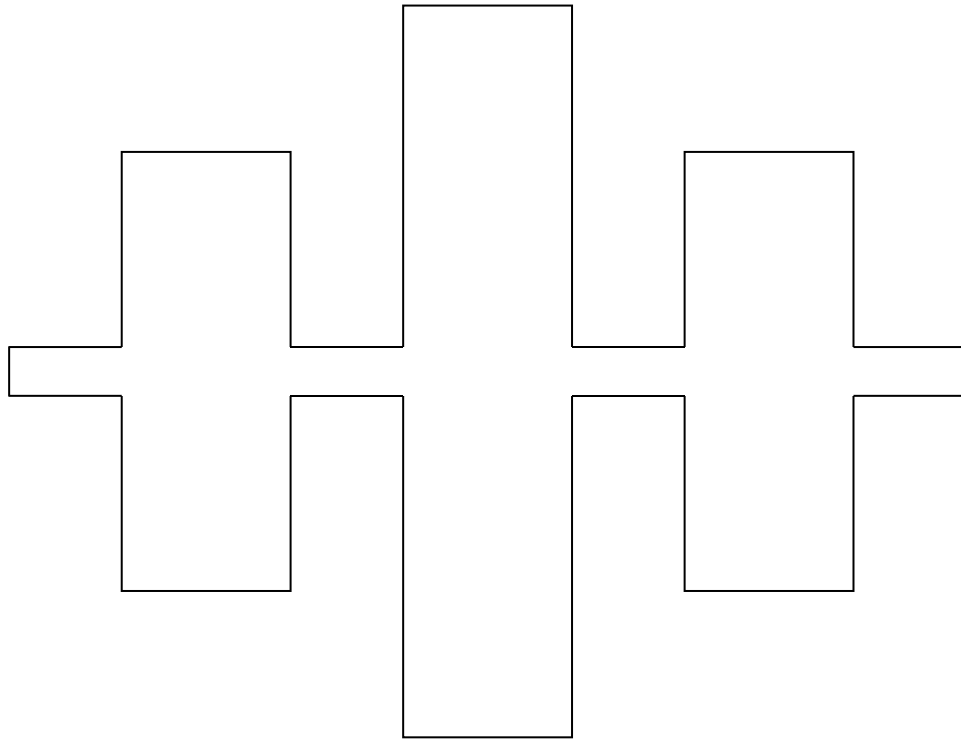
目录

1 设计方法

2 设计实例

1 设计方法

✧ 电路模型



1 设计方法

✧ 设计步骤

□ 第1步：理论计算→微带线参数

- ✓ 计算集总参数滤波器各元件的实际值 L_k, C_k
- ✓ 计算微带线宽 W_h 和 W_l (分别对应最高和最低特征阻抗 Z_h 和 Z_l)
- ✓ 计算微带线长 $l_L = vp_h L_k / Z_h$ 和 $l_C = vp_l C_k Z_l$ (vp_h, vp_l 为 Z_h, Z_l 对应相速)

□ 第2步：仿真验证

- ✓ 滤波器传输线原理图的建立及仿真
- ✓ 滤波器微带线原理图的建立及仿真
- ✓ 滤波器版图的生成及仿真

2 设计实例

设计一个阶跃阻抗的最平坦低通滤波器，截止频率为2.5GHz，在4GHz处插入损耗至少为22dB，滤波器阻抗为50欧。实现该滤波器的微带线最高阻抗为120Ω，最低阻抗为20Ω。微带基片参数如下：厚度 $d=1.58$ mm， $\epsilon_r=4.2$ ， $\tan\delta=0.02$ ，铜导带厚度0.5 mil。

□ 第1步 (公式计算)：理论计算→微带线参数

✓ 计算集总参数滤波器各元件的真实值 L_k, C_k

参数	R_g	C_1	L_2	C_3	L_4	C_5	L_6	R_L
实际值	50 Ω	0.659 pF	4.502 nH	2.460 pF	6.149 nH	1.800 pF	1.648 nH	50 Ω

2 设计实例

✓ 计算 W_h 和 W_l :

- $W_h = 11.3 \text{ mm}$

- $W_l = 0.41 \text{ mm}$

v_h 和 v_l 计算方法:

$$v_p = c / \sqrt{\epsilon_e}, \text{ 其}$$

$$\epsilon_e = \frac{\epsilon_r + 1}{2} +$$

$$\frac{\epsilon_r - 1}{2} \frac{1}{\sqrt{1 + 12d/W}}$$

The screenshot shows the LineCalc software interface with the following parameters and results:

Component: Type: MLIN, ID: MLIN: MLIN_DEFAULT

Substrate Parameters:

ID	MSUB_DEFAULT
Er	4.200 N/A
Mur	1.000 N/A
H	1.580 mm
Hu	3.9e+34 mil
T	0.500 mil
Cond	5.8e7 N/A

Physical Parameters:

W	11.378700 mm
L	1581.673228 mil
	N/A
	N/A

Electrical Parameters:

Z0	20.000 Ohm
E_Eff	230.000 deg
	N/A
	N/A

Component Parameters:

Freq	2.500 GHz
Wall1	mil
Wall2	mil

Calculated Results:

- K_Eff = 3.636
- A_DB = 0.345
- SkinDepth = 0.052

A diagram on the right shows a cross-section of a microstrip line with width W , length L , and thickness d . The diagram is labeled with 1 and 2.

2 设计实例

✓ 计算微带线长 l_L 和 l_C

- $l_L = v p_h L_k / Z_h$

- $l_C = v p_l C_k Z_l$

参数	R_g	C_1	L_2	C_3	L_4	C_5	L_6	R_L
实际值	50 Ω	0.659 pF	4.502 nH	2.460 pF	6.149 nH	1.800 pF	1.648 nH	50 Ω

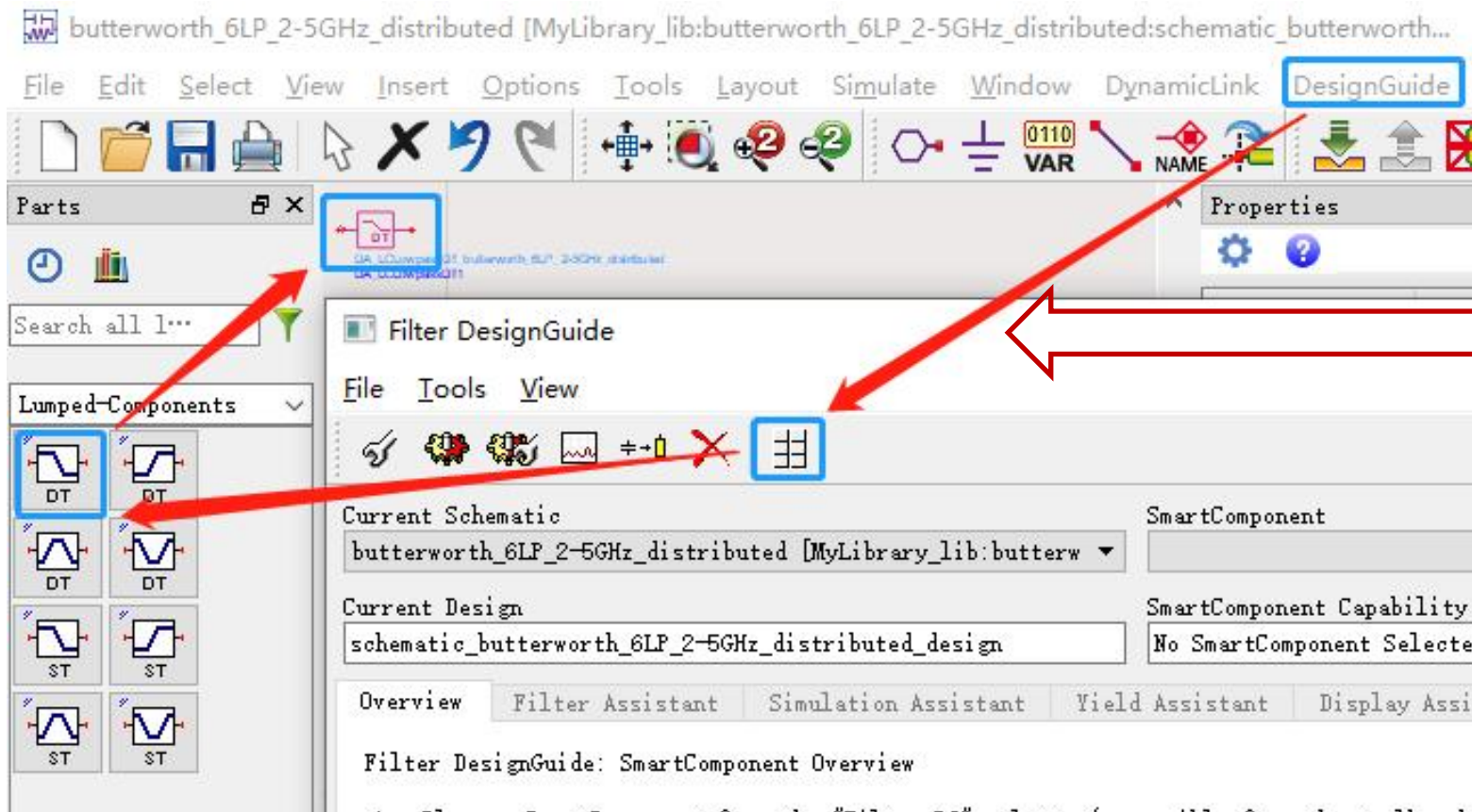


段数		1	2	3	4	5	6	
宽度/mm	3.14	11.3	0.41	11.3	0.41	11.3	0.41	3.14
长度/mm	-	2.09	6.69	7.80	9.13	5.71	2.45	-

2 设计实例

□ 第1步 (滤波器设计向导工具) : 理论计算→微带线参数

✓ 调出向导工具



DesignGuide→Filter



2 设计实例

✓ 向导工具界面

The screenshot displays the Filter DesignGuide software interface. The window title is "Filter DesignGuide". The menu bar includes "File", "Tools", and "View". The toolbar contains icons for undo, redo, save, print, zoom, and other functions.

Key parameters and settings are visible:

- Current Schematic:** butterworth_6LP_2-5GHz_distributed_design [MyLibrary_lib:...] | SmartComponent: DA_LCLowpassDT1
- Current Design:** schematic | SmartComponent Capability: Design, Simulate, Yield, Display
- Response Type:** Maximally Flat
- Impedances:** Source: 50, Load: 50
- First Element:** Parallel
- Order (N):** 6
- Design Information:** Order: 6, Minimum Insertion Loss: 0.0000
- Ap (dB):** 3
- As (dB):** 22
- Realizations:** View All (unchecked), Max #: 1
- Graph Parameters:** Fp: 2.5, Fs: 4, Units: GHz

The central graph shows a magnitude response curve on a grid. The curve starts at a high magnitude at low frequencies and rolls off towards a stopband. Vertical lines indicate the passband edge (Fp) and stopband edge (Fs).

Buttons at the bottom include "Design", "Redraw", and "Help".

2 设计实例

✓ 计算集总参数滤波器各元件的真实值 L_k, C_k

- 查看各元件的实际值
- 生成集总参数滤波器原理图

The screenshot shows the Filter DesignGuide software interface. The 'Yield Assistant' tab is active, displaying 'Automated SmartComponent Yield Simulation' settings. A red arrow points from the 'View Components' button in the Yield Assistant to the 'View Components' button in the 'Statistical Component Values' dialog box. The dialog box contains a table with the following data:

Component	at Nominal Valu	Statistics	pt Nominal Valu	Optimization
C1	658.82 fF	none	658.82 fF	none
L1	4.5 nH	none	4.5 nH	none
C2	2.46 pF	none	2.46 pF	none
L2	6.15 nH	none	6.15 nH	none
C3	1.8 pF	none	1.8 pF	none

The screenshot shows the circuit schematic and the 'Modify Component Parameters:1' dialog box. The schematic is a ladder network with three series inductors (L1, L2, L3) and three shunt capacitors (C1, C2, C3). The components are labeled with their nominal values and optimization parameters. The 'Modify Component Parameters:1' dialog box is open, showing the 'Parameters' section with 'C=658.82 fF' selected. A red arrow points from the 'Modify Statistics/Optimization' button in the 'Statistical Component Values' dialog to the 'Modify Component Parameters:1' dialog.

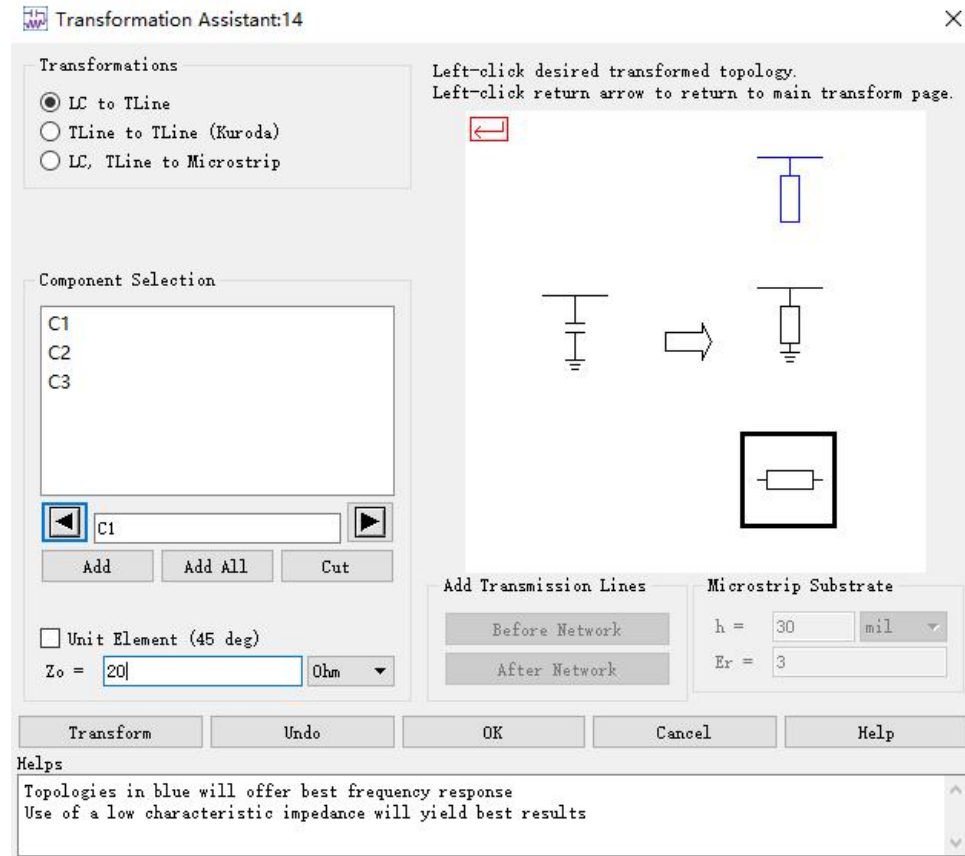
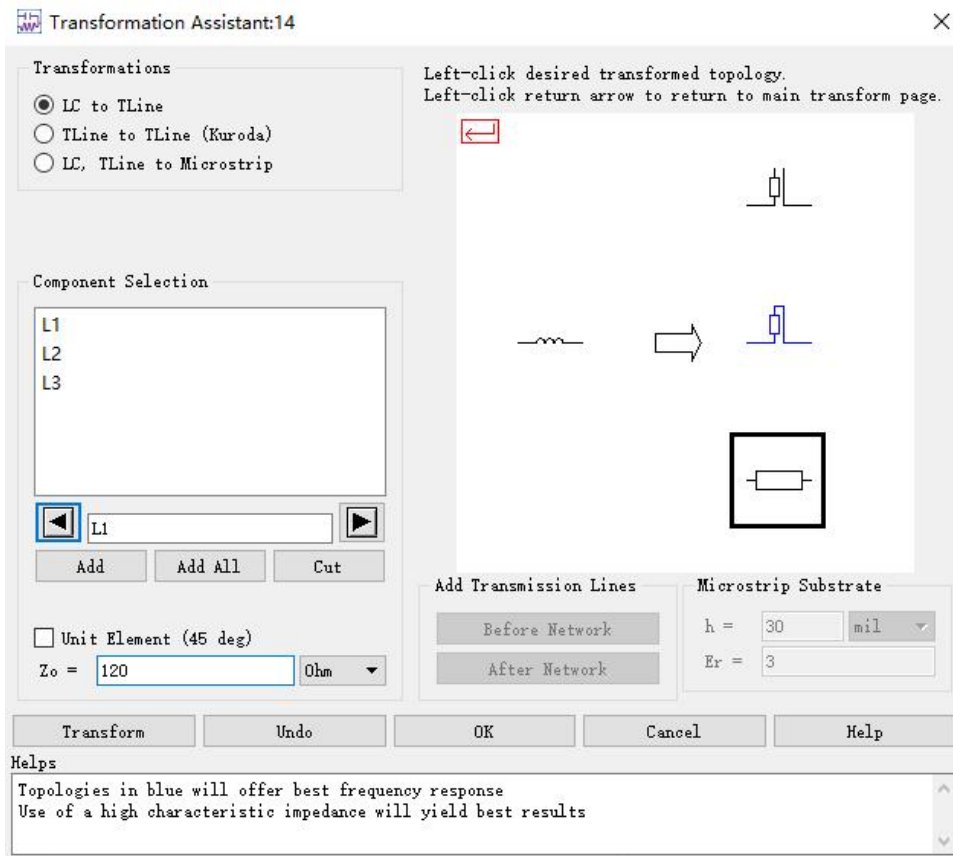
Statistical Component Values Table:

Component	at Nominal Valu	Statistics	pt Nominal Valu	Optimization
C1	658.82 fF	none	658.82 fF	none
L1	4.5 nH	none	4.5 nH	none
C2	2.46 pF	none	2.46 pF	none
L2	6.15 nH	none	6.15 nH	none
C3	1.8 pF	none	1.8 pF	none

2 设计实例

✓ 计算微带线线宽 W_h , W_l 和线长 l_L , l_C

- 进入设计界面: Tools→Distributed Element Transformations
- 转换为传输线: LC→Tline



以上内容仅为本文档的试下载部分，为可阅读页数的一半内容。如要下载或阅读全文，请访问：<https://d.book118.com/135223010231011204>