

## The Twelfth (or Sixth) Wavelength Transformer

With great respect for **Peter (B) Bramham**, inventor of the sixth wavelength transformer.

[www.lapayev.com](http://www.lapayev.com)

Let me introduce to you an old friend – the PCB printed impedance transformer, many designers well know it and use it, it would seem nothing new. But there is one addition clarification: for the calculation of the transformer's circuit we need know a PCB's material Dielectric Constant  $\epsilon_r$ , even more - we should figure out the  $\epsilon$  effective parameter. Furthermore it should be noted that the  $\epsilon$  dielectric effective depends on the physical dimensions of the transmission line. The Twelfth Wavelength Transformer includes two lines with different width – Z1 and Z2; hence we have two different  $\epsilon$  effective parameters. Therefore both of them should be considered to the accurately calculate of the circuit. It results the two different lengths of the Z1 and Z2 lines.

On the other hand the error should be not too significant, you can ignore this, but don't try to make your design worse - it should be itself... beware it.

Somehow my Twelfth Wavelength Calculator should calculate and consider two different  $\epsilon$  effective parameters, Useful for the outer layers only, enjoy.

### Lm/ $\lambda$ ratio calculator Step 1

Enter the Lower impedance Z1 >  Ohms

Enter the Higher impedance Z2 >  Ohms

Z2 / Z1 ratio =	1.46
N coefficient =	3.144932
X function =	1.773396
Lm =	29.41821 degree
Lm / $\lambda$ ratio =	0.163435
La, Lb / $\lambda$ ratio =	0.081718
$\lambda$ / La, Lb ratio =	12.237206

### $\epsilon_{eff}$ calculator / note: W>H Step 2

Enter the Dielectric Constant  $\epsilon_r$  >   $\epsilon_r$

Enter the Thickness of Dielectric H >  MILs

Enter Width of Microstrip Z1 Line W1 >  MILs

Enter Width of Microstrip Z2 Line W2 >  MILs

Z1 line Dielectric Constant Effective  $\epsilon_{eff}(Z1)$  =   $\epsilon_{eff} Z1$

Z2 line Dielectric Constant Effective  $\epsilon_{eff}(Z2)$  =   $\epsilon_{eff} Z2$

### La and Lb length calculator

Enter the transformer Frequency f >  GHz

$\epsilon_{eff} Z1$ sq.root =	1.83316666
Z1 Fraction of C velocity PCB =	0.54550414 Vp
Z1 Velocity of Electromagnetics waves in PCB =	163538027 m/sec
$\epsilon_{eff} Z2$ sq.root =	1.78289091
Z2 Fraction of C velocity in PCB =	0.56088681 Vp
Z2 Velocity of Electromagnetics waves in PCB =	168149635.4 m/sec

Z1 Wave whole length $\lambda(Z1)$ =	103.806 mm
	4086.85 MILs
Z2 Wave whole length $\lambda(Z2)$ =	106.733 mm
	4202.09 MILs

The result:

La length =	8.483 mm
	333.98 MILs
Lb length =	8.722 mm
	343.39 MILs

The Result

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The Reference: P. Bramham, the convenient transformer for matching co-axial lines, (Nov. 1959), <http://doc.cern.ch/yellowrep/1959/1959-037/p1.pdf>