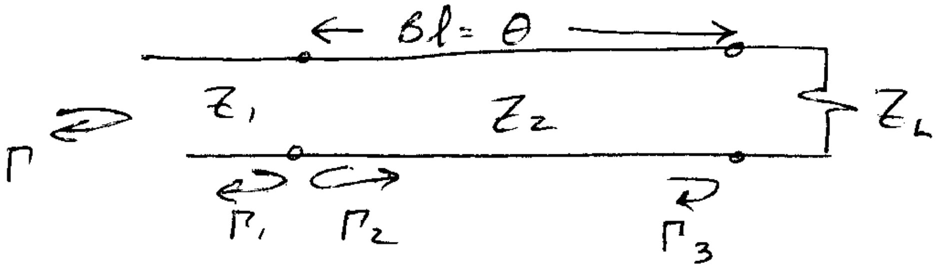
Broad Band Matching

Text Sections 5.5 + 5.6

General Theory:

How do you design a Broad Band match network?
Binomial, Chebyshev
Eq. 5.16, 20

Reconsider Single Section transformer:



Find Γ!

$$\Gamma_1 = \frac{Z_2 - Z_1}{Z_2 + Z_1} \qquad \Gamma_2 = \frac{Z_1 - Z_2}{Z_2 + Z_1} = -\Gamma_1$$

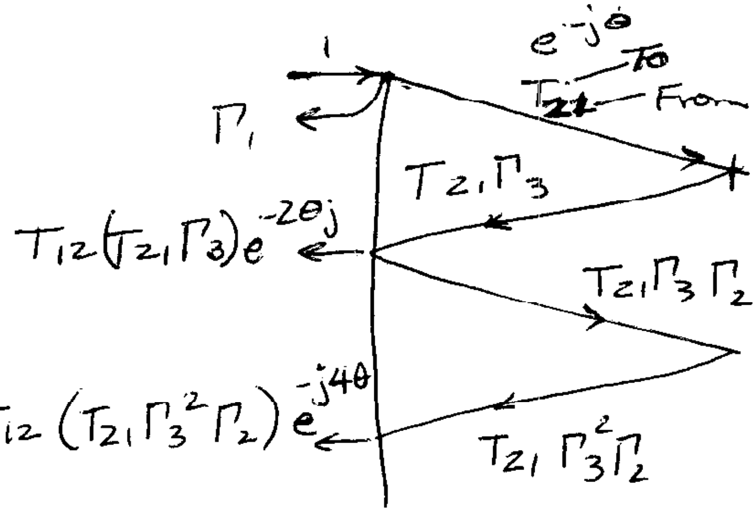
$$\Gamma_3 = \frac{Z_L - Z_2}{Z_L + Z_2} \qquad \begin{aligned} T_{12} &= 1 + \Gamma_2 \\ T_{21} &= 1 + \Gamma_1 \end{aligned}$$

$\Gamma = \Gamma_1 +$

$T_{12} T_{21} \Gamma_3 e^{-j\theta 2}$

$+ T_{12} T_{21} \Gamma_3^2 \Gamma_2 e^{-j4\theta}$

$+ \ldots$

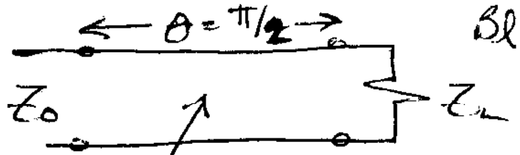


$$\Gamma = \Gamma_1 + T_{12}(T_{21}\Gamma_3)e^{-j2\theta} \sum_{n=0}^{\infty} \Gamma_2^n \Gamma_3^n e^{-jn\theta}$$

Band 3 11-18-01

Use this to design optimal broadband matching

1. Quarter wave transformer



$$\beta l = \left(\frac{2\pi}{\lambda}\right)\left(\frac{\lambda}{4}\right) = \pi/2$$

$Z_2 = \sqrt{Z_0 Z_L}$

$\Gamma = 0$ @ single frequency

2. Binomial Matching Network

Let $\Gamma(\theta) = A\,(1+e^{-j2\theta})^N$ ← # of sections $= A\sum_{n=0}^{N} C_n^N e^{-2jn\theta}$ ← Binomial coefficients

Produces flattest response of passband
best matching @ desired frequency some mismatch outside

Design process:

$$A = 2^{-N}\left|\frac{Z_L - Z_0}{Z_L + Z_0}\right|$$

← Use length of line to convert Z_L complex to Z_L' real

N = # sections

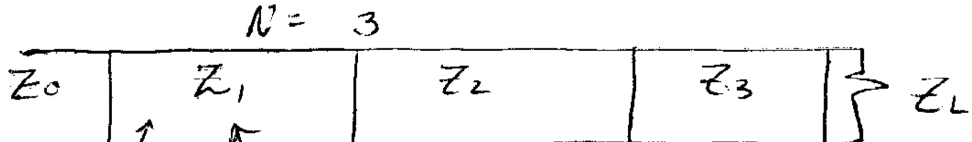
$BW = \frac{\Delta f}{f_0}$

$$C_n^N = \frac{N!}{(N-n)!\,n!} \quad \text{for } n = 0 \text{ to } N-1$$

$$\ln\frac{Z_{n+1}}{Z_n} = 2AC_n^N$$

Length: $\theta = 0$
$\beta L = 0, 360, \ldots$
$L = m\lambda$

N = 3



$C_0^3 \Rightarrow \ln\frac{Z_1}{Z_0} = 2AC_0^3$

3. Chebyshev.
   Similar to binomial, but different calculation of Z_n

4. Tapered lines

   If series (cascade) of lines provides good matching, why not a continuously-varying impedance, ie a tapered line

   Many possibilities

Research Areas:

5. Optimal matching found using optimization theory on any of the above methods

   You provide a desired distribution, optimization provide a "closest fit" sol^{n}

   This is now commonly used for applications where optimal matching with minimal weight (# sections) is required & high power antenna systems.

   Additional sections tend to increase noise in circuit, also, so they should be minimized

6. Use of PML theory may be applied to numerical work as well.

   Above theory is for normal incidence or TEM behavior. NonTEM is more complicated and can also be optimized.