Matching Techniques

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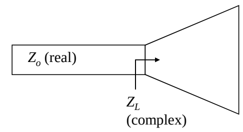
Ref. Balanis sect. 9.8

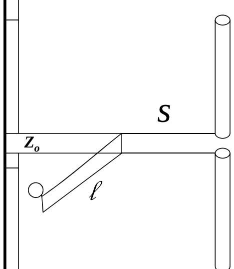
Matching Techniques

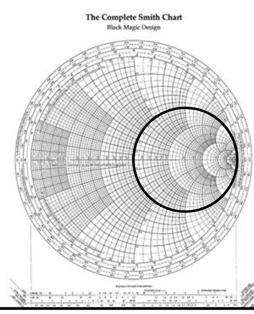
- Matching over the desired frequency range when connecting the T.L. to the antenna



- Types
  - Stub-matching
  - λ/4 transformer: single or multiple

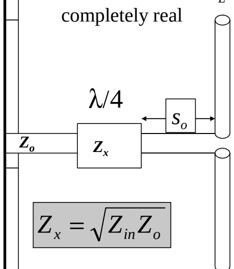
Stub-matching



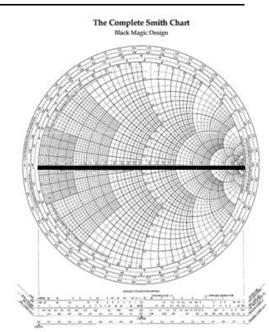


λ/4 transformer-matching: Single Section

- First move so that Z_L is completely real

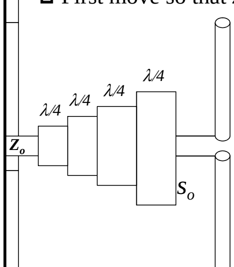


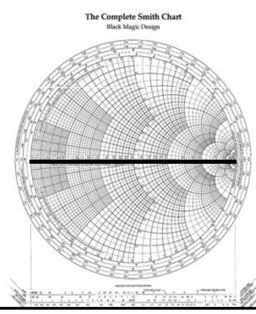
$$Z_x = \sqrt{Z_{in} Z_o}$$



λ/4 transformer-matching: Multiple- Section- provides broader BW

- First move so that Z_L is completely real



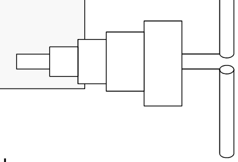


Multiple sections: Quarter-wave Xmer

- N-sections

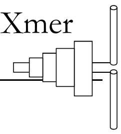
$$\Gamma_{in}(f) = \rho_o + \rho_1 e^{-j2\theta} + \rho_2 e^{-j4\theta} + \ldots \rho_N e^{-j2N\theta}$$
$$= \sum_{n=0}^{N} \rho_n e^{-j2n\theta}$$
where
$$\rho_n = \frac{Z_{n+1} - Z_n}{Z_{n+1} + Z_n} = C_n^N$$

$$\theta = k\Delta l = \frac{2\pi}{\lambda}\frac{\lambda_o}{4} = \frac{\pi}{2}\frac{f}{f_o}$$



- Can be implemented several ways
  - Binomial
  - Tschebyscheff

Multiple sections: Quarter-wave Xmer



- For symmetrical Xmer,

$$\Gamma_{in}(f) = 2e^{-j2N\theta}(\rho_o \cos N\theta + \rho_1 \cos(N-2)\theta + \ldots$$

$$= 2^{-N}\left(\frac{R_L - Z_o}{R_L + Z_o}\right)\sum_{n=0}^{N} C_n^N e^{-j2n\theta}$$

$$\rho_n = 2^{-N}\left(\frac{R_L - Z_o}{R_L + Z_o}\right)C_n^N$$

- Binomial Coefficients

$$C_n^N = \frac{N!}{(N-n)!n!}$$

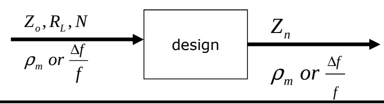
n=0,1,2,…N

Binomial Design for Multiple sections Quarter-wave Xmer

- Fractional Bandwidth: Use Radians!!!

$$\frac{\Delta f}{f_o} = \frac{2(f_o - f_m)}{f_o} = 2 - \frac{4}{\pi}\cos^{-1}\left[\frac{\rho_m(R_L + Z_o)}{(R_L - Z_o)}\right]^{1/N}$$

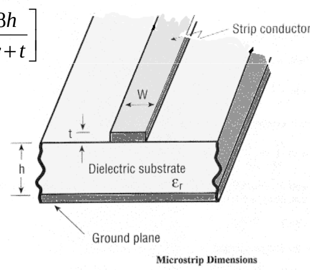
where ρ_m= maximum value of reflection coefficient which can be tolerated within the bandwidth.



Implementing with Microstrip

- For Microstrip lines:

$$Z_c = \frac{87}{\sqrt{\varepsilon_r + 1.47}}\ln\left[\frac{5.98h}{0.8w + t}\right]$$



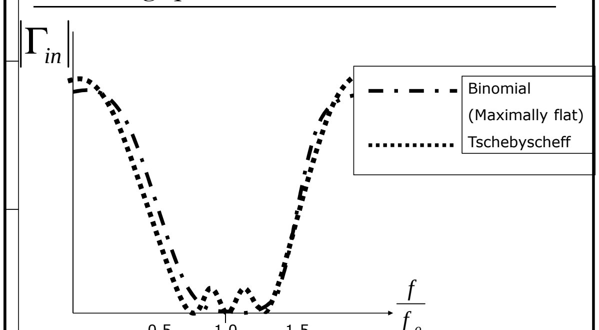
Tschebyscheff Design for Multiple sections Quarter-wave Xmer

$$\Gamma_{in}(f) = 2e^{-j2N\theta}(\rho_o \cos N\theta + \rho_1 \cos(N-2)\theta + \ldots$$

$$= e^{-j2N\theta}\left[\frac{Z_L - Z_o}{Z_L + Z_o}\right]\frac{T_N(\sec\theta_m \cos\theta)}{T_N(\sec\theta_m)}$$

$$\rho_m = \left[\frac{Z_L - Z_o}{Z_L + Z_o}\right]\frac{1}{T_N(\sec\theta_m)}$$

Comparison of frequency response for matching quarter-wave network



Matching-techniques

- There are other techniques for matching a line to the antenna;
  - T-Match
  - Gamma Match
  - Baluns