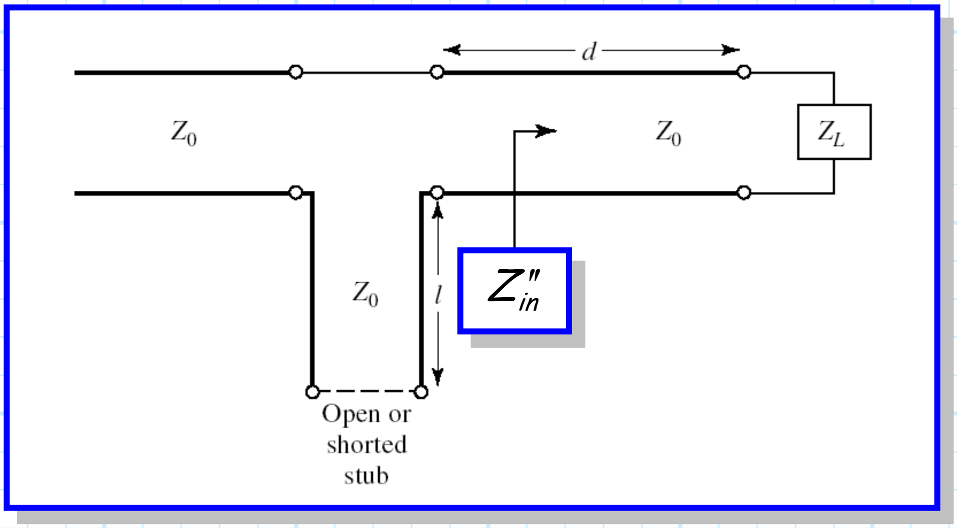
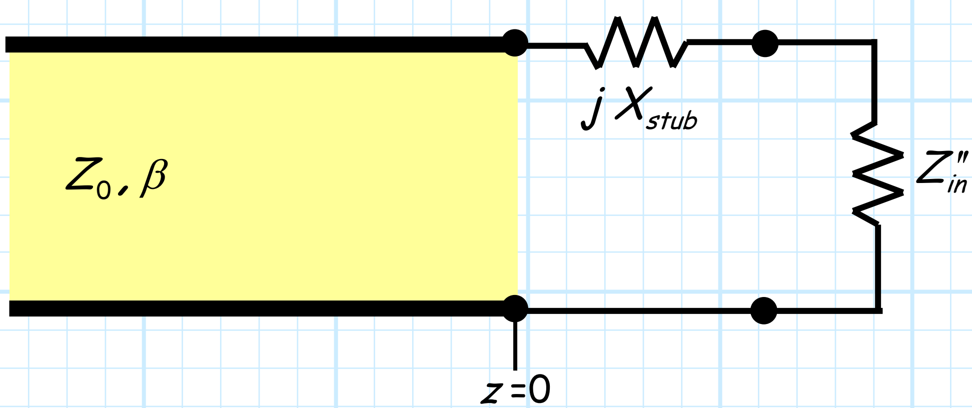
Series Stub Tuning

Consider the following transmission line structure, with a **series** stub:



Therefore an **equivalent** circuit is:



where of course:

$$Z''_{in} = Z_0 \left(\frac{Z_L + j\, Z_0 \tan \beta d}{Z_0 + j\, Z_L \tan \beta d} \right)$$

and the **reactance** jX_{stub} is either:

$$jX_{stub} = \begin{cases} -jZ_0 \cot\beta\ell & \text{for an open-circuit stub} \\ \\ jZ_0 \tan\beta\ell & \text{for an short-circuit stub} \end{cases}$$

Therefore, for a **matched** circuit, we **require**:

$$jX_{stub} + Z''_{in} = Z_0$$

i.e.,

$$\text{Re}\{Z''_{in}\} = Z_0$$

and

$$\text{Im}\{jX_{stub} + Z''_{in}\} = 0 \quad \Rightarrow \quad X_{stub} = -X''_{in}$$

where

$$X''_{in} \doteq \text{Im}\{Z''_{in}\}$$

Note the **design parameters** for this stub tuner are transmission line **lengths** d and ℓ. More specifically we:

1) Set d such that $\text{Re}\{Z''_{in}\} = Z_0$.

2) Then set ℓ such that $X_{stub} = -X''_{in}$.

We have **two** choices for determining the lengths d and ℓ. We **can** use the design equations (5.14, 5.15, 5.16) on pp. 235.

OR

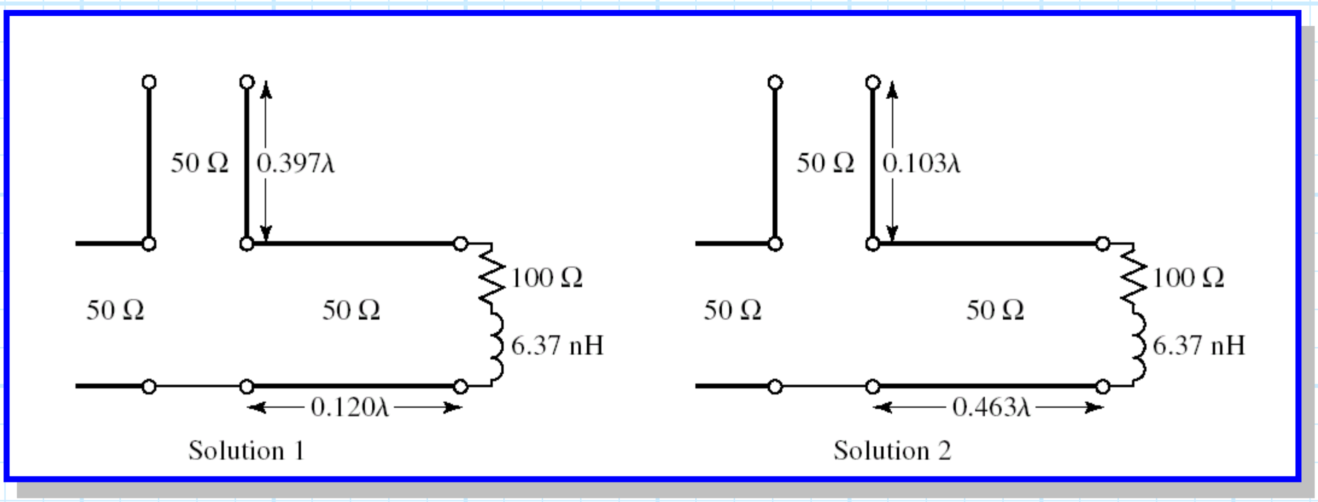
we can use the **Smith Chart** to determine the lengths!

1) Rotate clockwise around the Smith Chart from z_L until you intersect the ***r* = 1 circle**. The "length" of this rotation determines the value *d*. Recall there are **two** possible solutions!

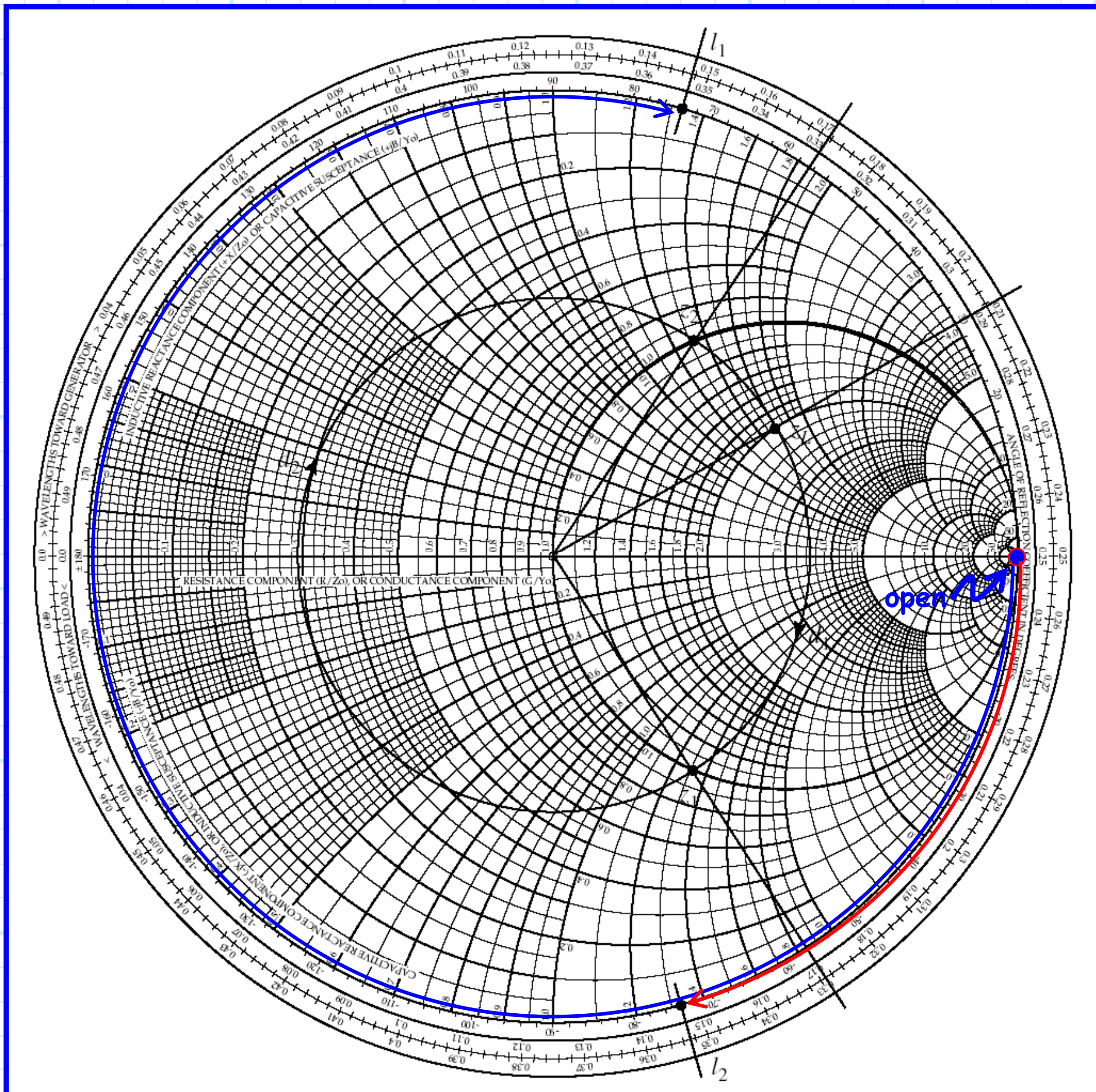
2) Rotate clockwise from the short/open circuit point around the ***r* = 0 circle** until x_{stub} equals $-x''_{in}$. The "length" of this rotation determines the stub length ℓ.

For example, your **book** describes the case where we want to match a load of $Z_L = 100 + j80$ (at 2 GHz) to a transmission line of $Z_0 = 50\Omega$.

Using **open** stubs, we find **two** solutions to this problem:



Whose values where determined from a **Smith Chart**:



Again, we should use the solution with the **shortest** transmission lines, although in **this** case that distinction is a bit **ambiguous**. As a result, the bandwidth of each design is about the same (depending on how **you** define **bandwidth**!).