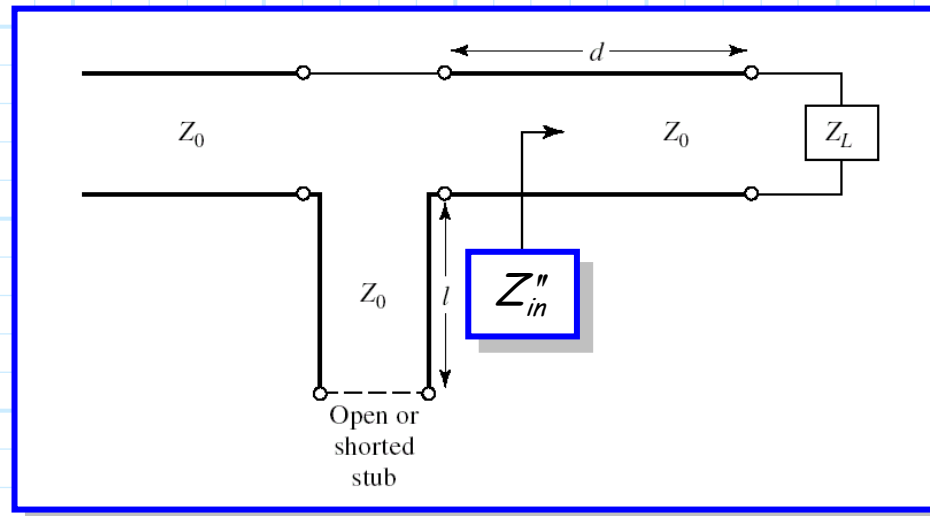
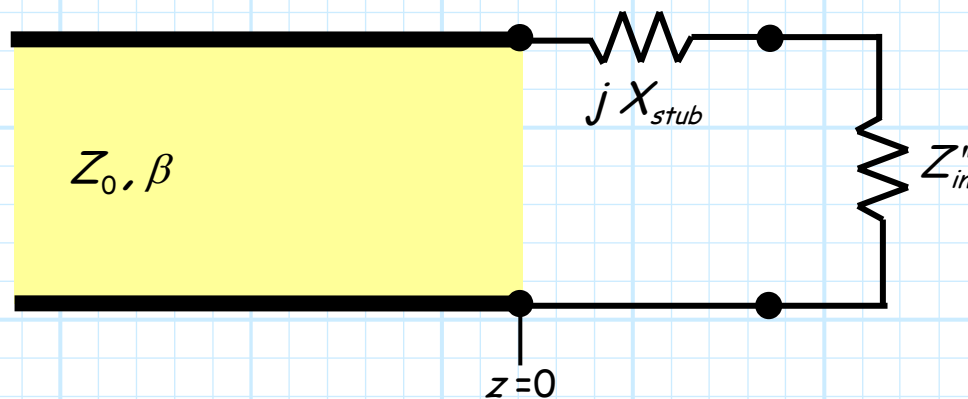


Series Stub Tuning

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



Therefore an **equivalent** circuit is:



where:

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

and the reactance jX_{stub} is either:

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

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

$$jX_{stub} + Z_{in}'' = Z_0$$

i.e.,

$$\text{Re}\{Z_{in}''\} = Z_0$$

and

$$\text{Im}\{jX_{stub} + Z_{in}''\} = 0 \Rightarrow X_{stub} = -X_{in}''$$

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

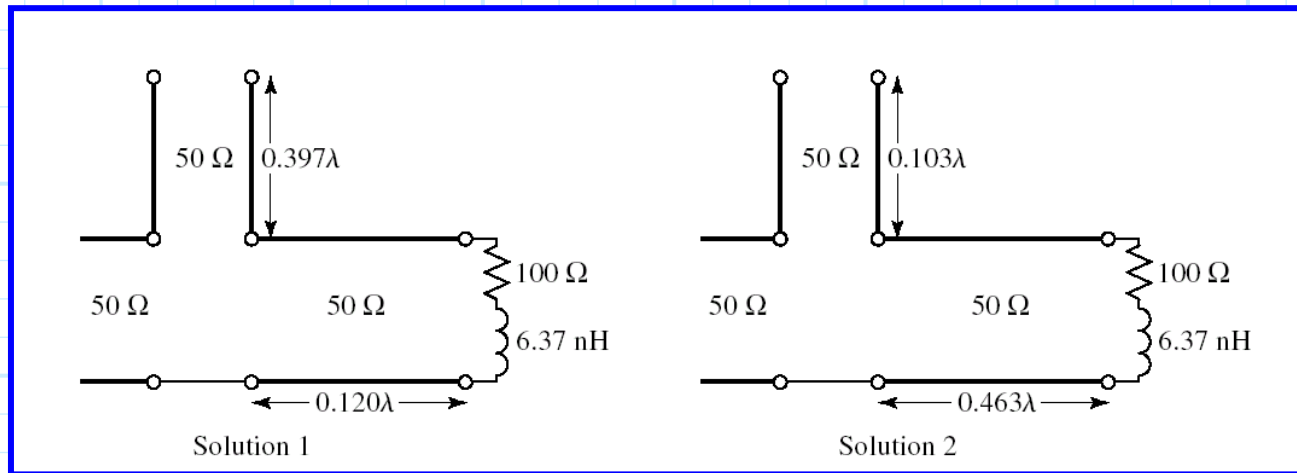
we can use the **Smith Chart** to determine the lengths!

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!

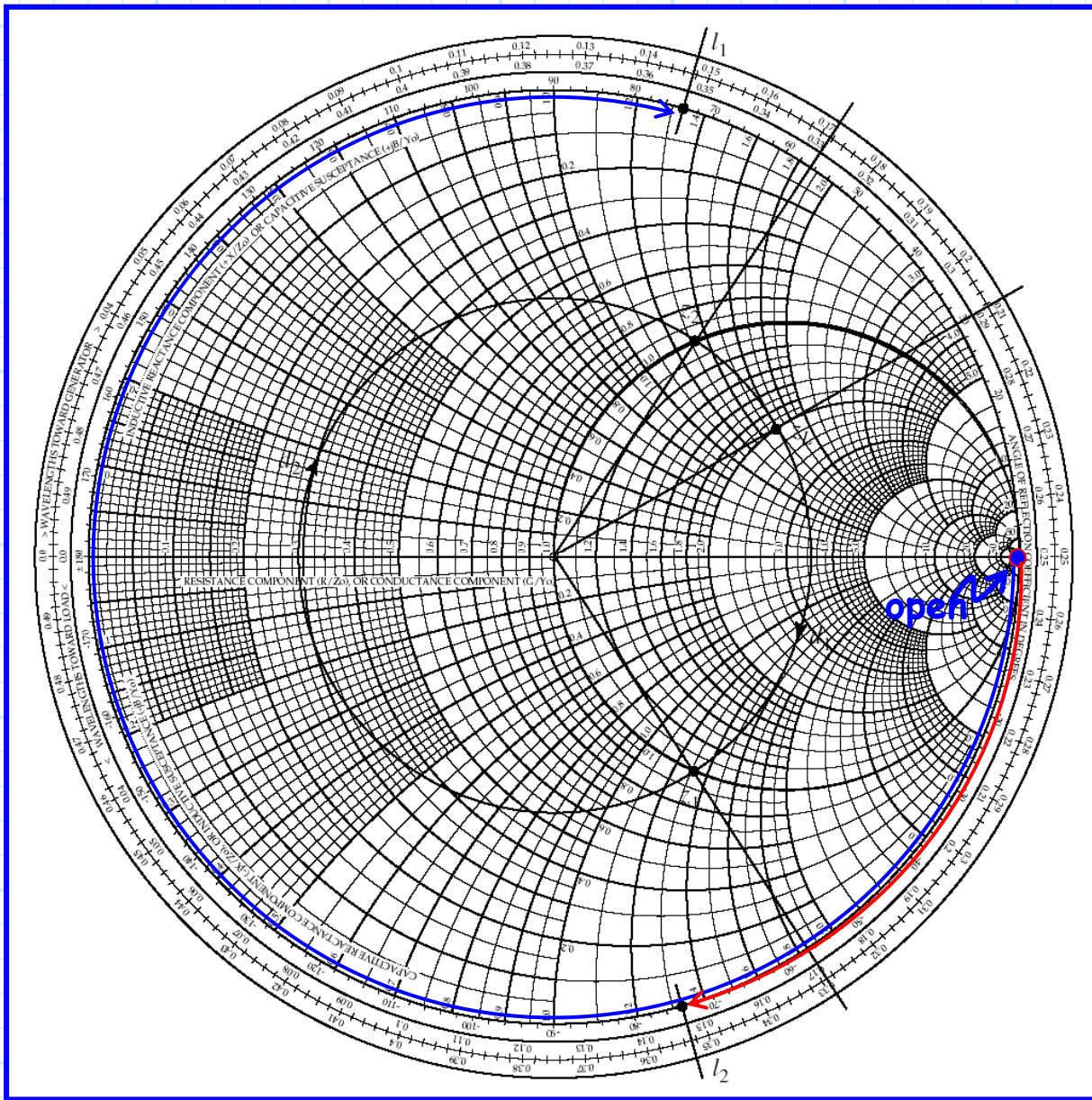
2) Rotate clockwise from the short/open circuit point around the $r = 0$ circle until x_{stub} equals $-x_{in}''$. The "length" of this rotation determines the stub length ℓ .

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 were 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**!).

