Single Stub Matching

- It consists of 2 sections of transmission lines:
  - One of length $d$ connecting the load to the feedline at AA’
  - One of length $l$ connected in parallel
- This stub is shorted (could be open circuit)
- Since the stub is added in parallel, it is easier to work with admittances $y$

Matching procedure consists of 2 steps:

1. Transform $Y_L = 1/Z_L$ into $Y_d = Yo + jB$
2. Select length $l$ such that $Y_s = -jB \Rightarrow Yin = Yd + Ys = Yo$
   match
Example: A 50 Ω transmission line is connected to a cellular phone antenna with load impedance $Z_L = 25-j50$ Ω. Find the position and the length of a shunt short-circuit stub required to match the 50 Ω line.
Use Smith chart

Normalize load: \( Z_L = \frac{Z_L}{Z_0} = \frac{(25-j50)}{50} = 0.5 - j \) \( \rightarrow \) Point A

Draw constant SWR circle through point A

Obtain \( Y_L = 0.4 + j 0.8 \) (point B) at 0.115\( \lambda \).

In admittance domain \( r_L \) circles \( \rightarrow \) \( g_L \) circles

\& \( \chi_L \) circles \( \rightarrow \) \( b_L \) circles

For matching need to move towards generator a distance \( d \) such that \( Y_d \) has a real part equal to 1.

This condition is satisfied by two points C & D on Smith Chart, corresponding to the intersections of the SWR circle with the \( g_L = 1 \) circle.
Solution for point C:

\[ y_d = 1 + j \, 1.6 \text{ point C located at } 0.178\lambda \]

\[ d_{(B,C)} = (0.178 - 0.115)\lambda = 0.063\lambda \]

In order to match: \( y_{in} = 1 \)

But \( y_{in} \sim y_d + y_s = 1 + j1.6 + y_s = 1 \)

\[ \Rightarrow y_s = -j1.6 \]

So we need a stub with admittance \(-j1.6\).

The normalized admittance of a short is \(-j\infty\)

located at point E

Starting from E, we move twd’s generator until \( y = -j1.6 \rightarrow \text{point F (}0.34\lambda).\)

Distance E-F gives stub length:

\[ l = 0.34\lambda - 0.25 \lambda = 0.09 \lambda \]
Solution for point D:

\[ Y_d = 1 - j \ 1.6 \text{ point D located at } 0.321\lambda \]

\[ d_{(B,D)} = (0.321 - 0.115)\lambda = 0.206\lambda \]

In order to match: \( Y_{in} = 1 \)

The needed normalized input admittance of the stub is \( Y_s = + j \ 1.6 \), located at point G (0.16\lambda on WTG scale)

The normalized admittance of a short is \(-j\infty\) located at point E

Starting from E, we move twd's generator until \( Y = +j1.6 \) \( \rightarrow \) point G (0.25+0.16 = 0.41\lambda)

Distance E-G gives stub length:

\[ l = 0.25\lambda + 0.16 \lambda = 0.41\lambda \]