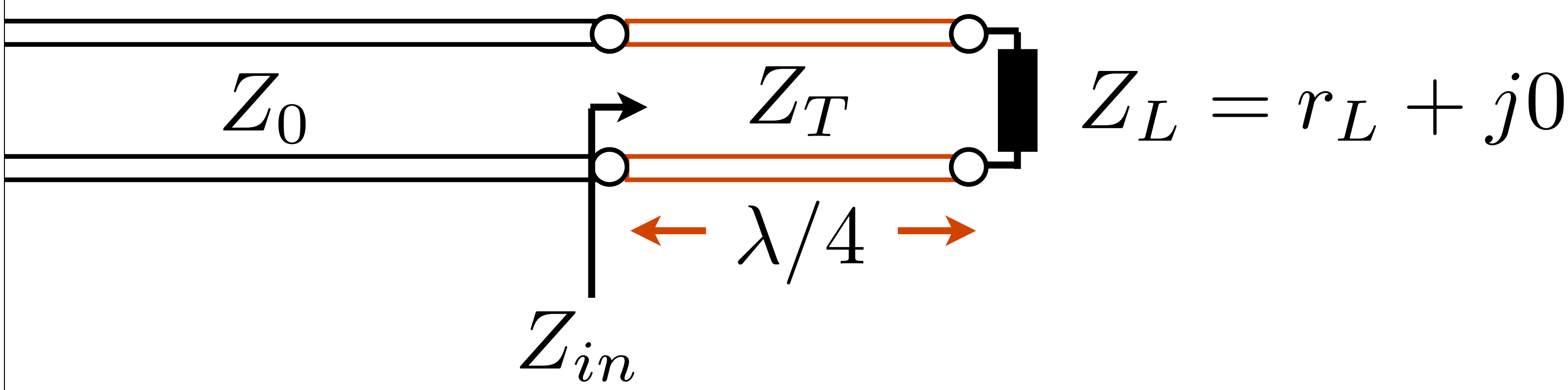
Impedance matching via QWT

Goal: Design a QWT matching network such that: $Z_{in} = Z_0$

$$z_{in} = 1 + j0$$

For Z_L purely real:



Since $Z_{in} Z_L = Z_T^2$

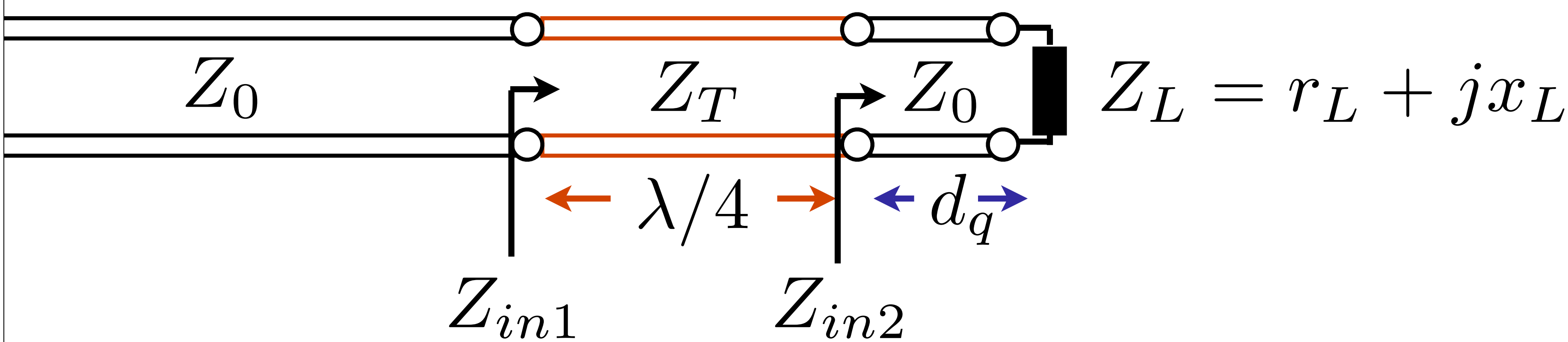
a match is achieved with a T.L having:

$$Z_T = \sqrt{Z_0 Z_L}$$

Impedance matching via QWT

Goal: Design a QWT matching network such that: $Z_{in} = Z_0$

For complex Z_L:



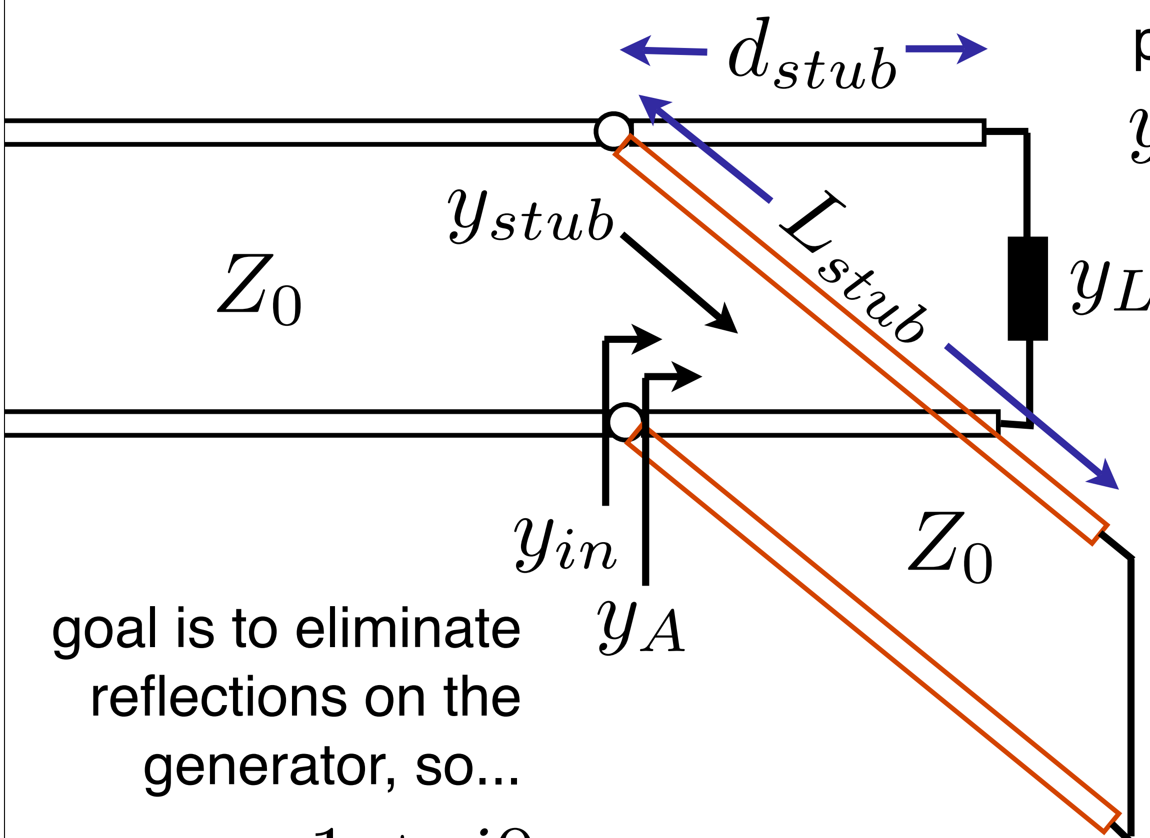
Now, $Z_{in1} Z_{in2} = Z_0 Z_{in2} = Z_T^2$

So that $Z_{in2} = Z_T^2 / Z_0$ must be purely real

Single stub tuning

stub is connected in parallel, so....

$$y_{in} = y_A + y_{stub}$$



stub T.L.s have either open or short terminations, so....

$$y_{stub} = jb_{stub}$$

goal is to eliminate reflections on the generator, so...

$$y_{in} = 1 + j0$$

Steps to Solve a Single-Stub Matching Problem

Goal: Design a single-stub matching network such that

$$Y_{IN} = Y_{STUB} + Y_A = Y_0$$

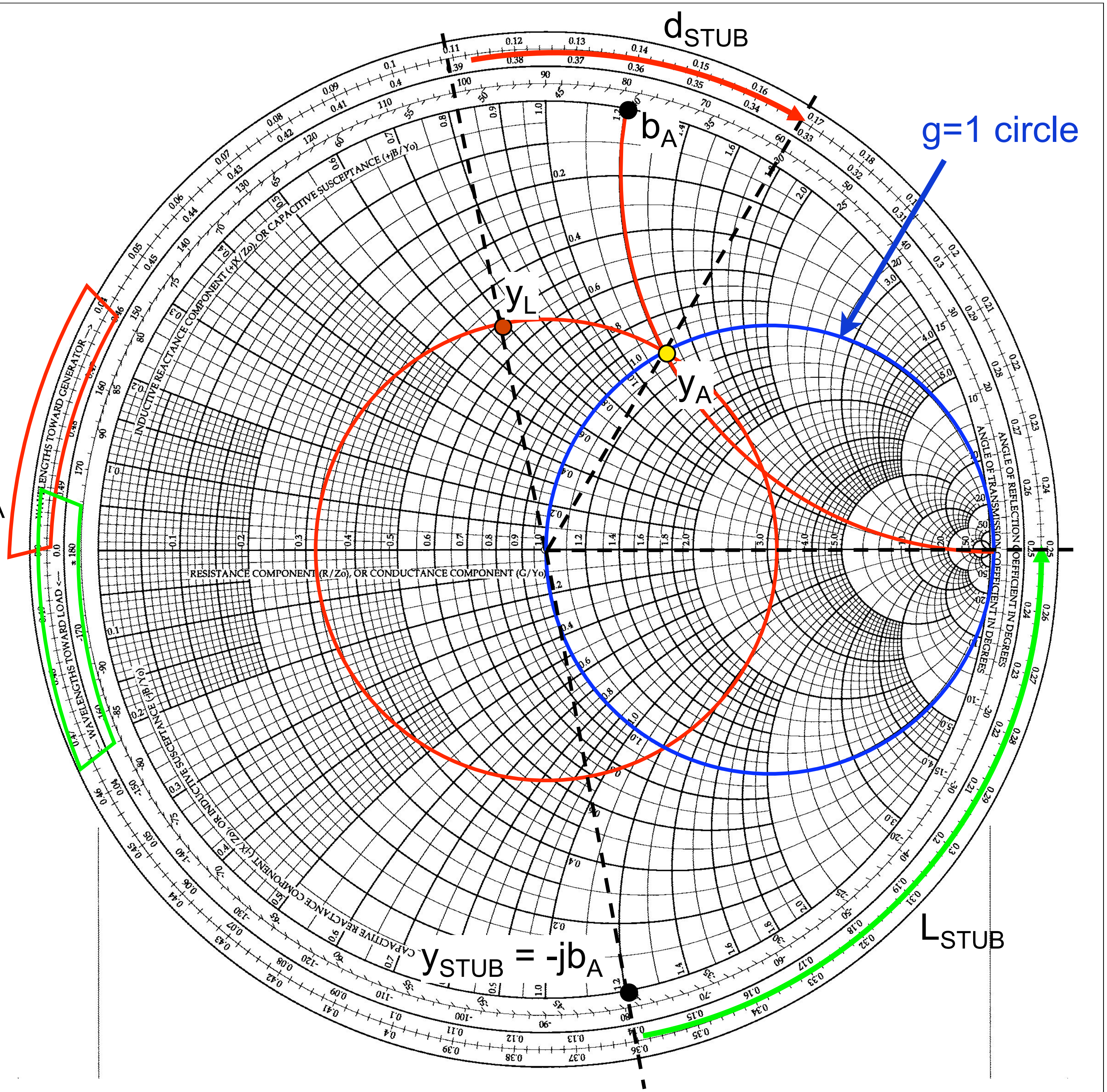
1) Convert the load to a normalized admittance: $y_L = g + jb$
2) Transform y_L along constant Γ *towards generator* until $y_A = 1 + jb_A$
   – This matches the network's conductance to that of the transmission line and determines d_{stub}
3) Find $y_{stub} = -jb_A$ on Smith Chart
4) Transform y_{STUB} along constant Γ *towards load* until we reach P_{SC} (for short-circuit stub) or P_{OC} (for open-circuit stub)
   – This cancels susceptance from (2) and determines L_{STUB}

1) Find y_L

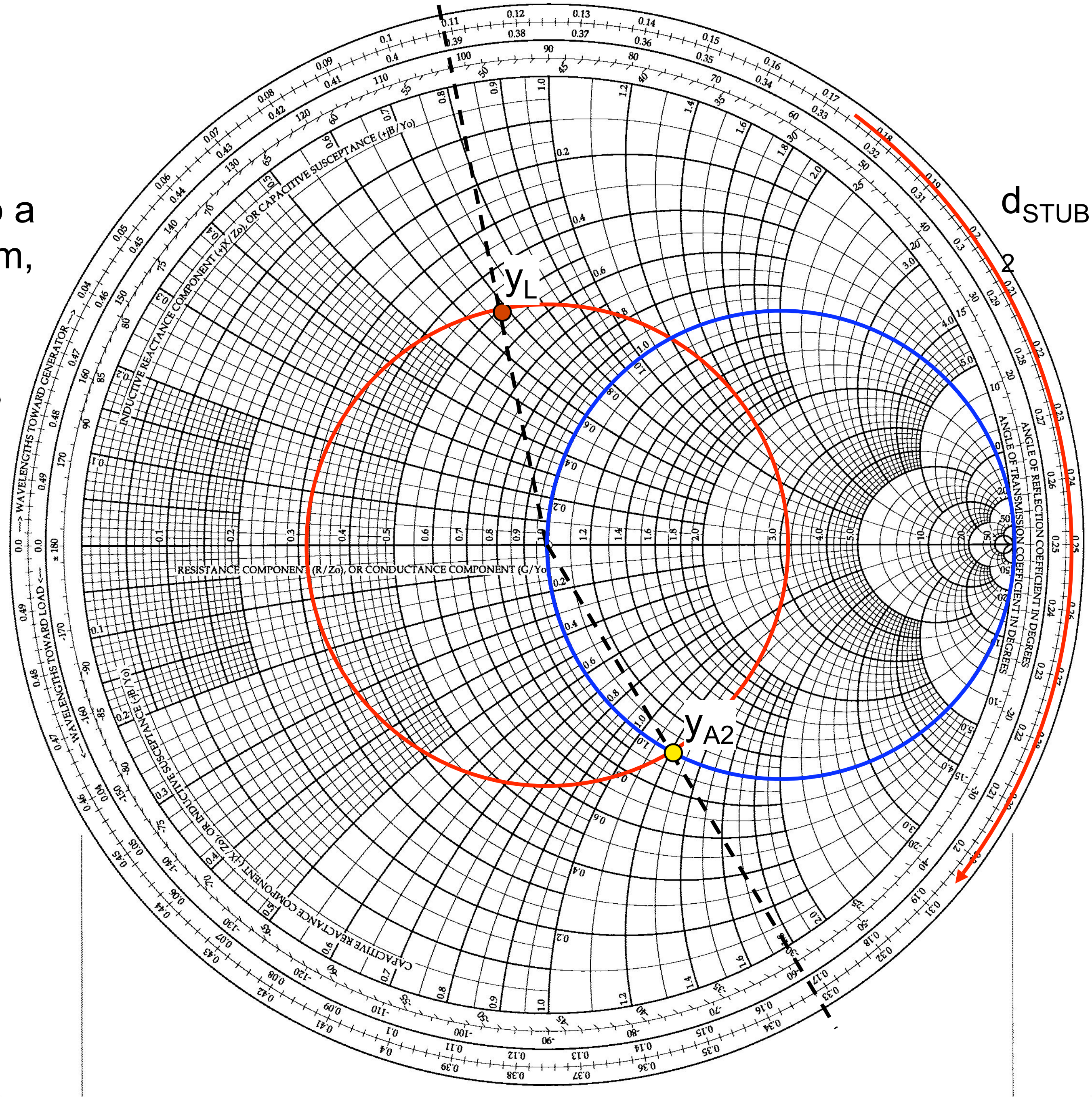
2) Transform y_L to $y_A = 1 + jb_A$

3) Find $y_{STUB} = -jb_A$

4) Transform y_{STUB} to P_{SC} (or P_{OC})



There is a second solution where the Γ circle and g=1 circle intersect. This is also a solution to the problem, but requires a longer d_{STUB} and L_{STUB} so is less desirable, unless practical constraints require it.



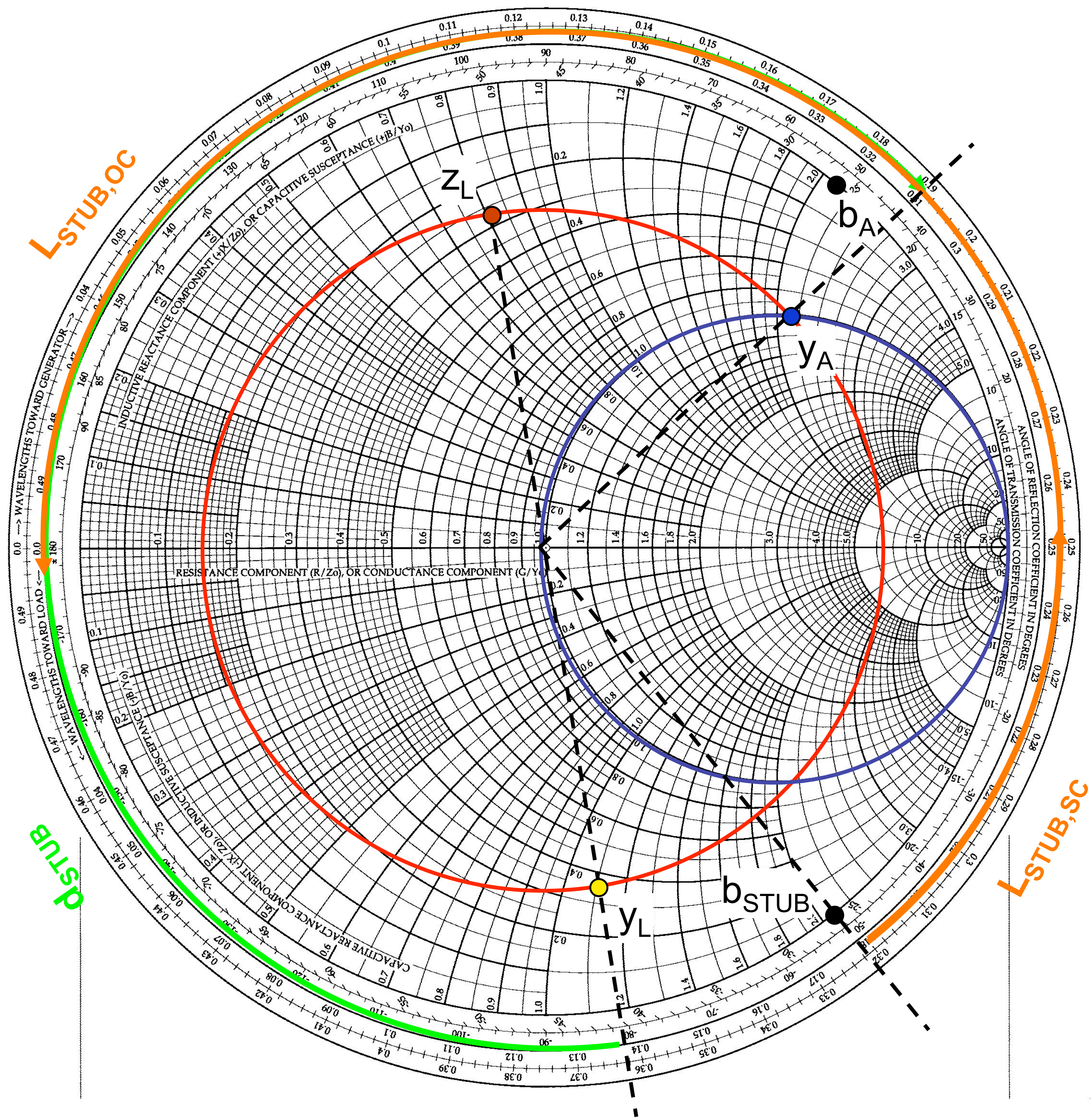
1) Find y_L

2) Rotate towards generator until intersection with g=1 circle (d_{STUB})

3) Read off b_A

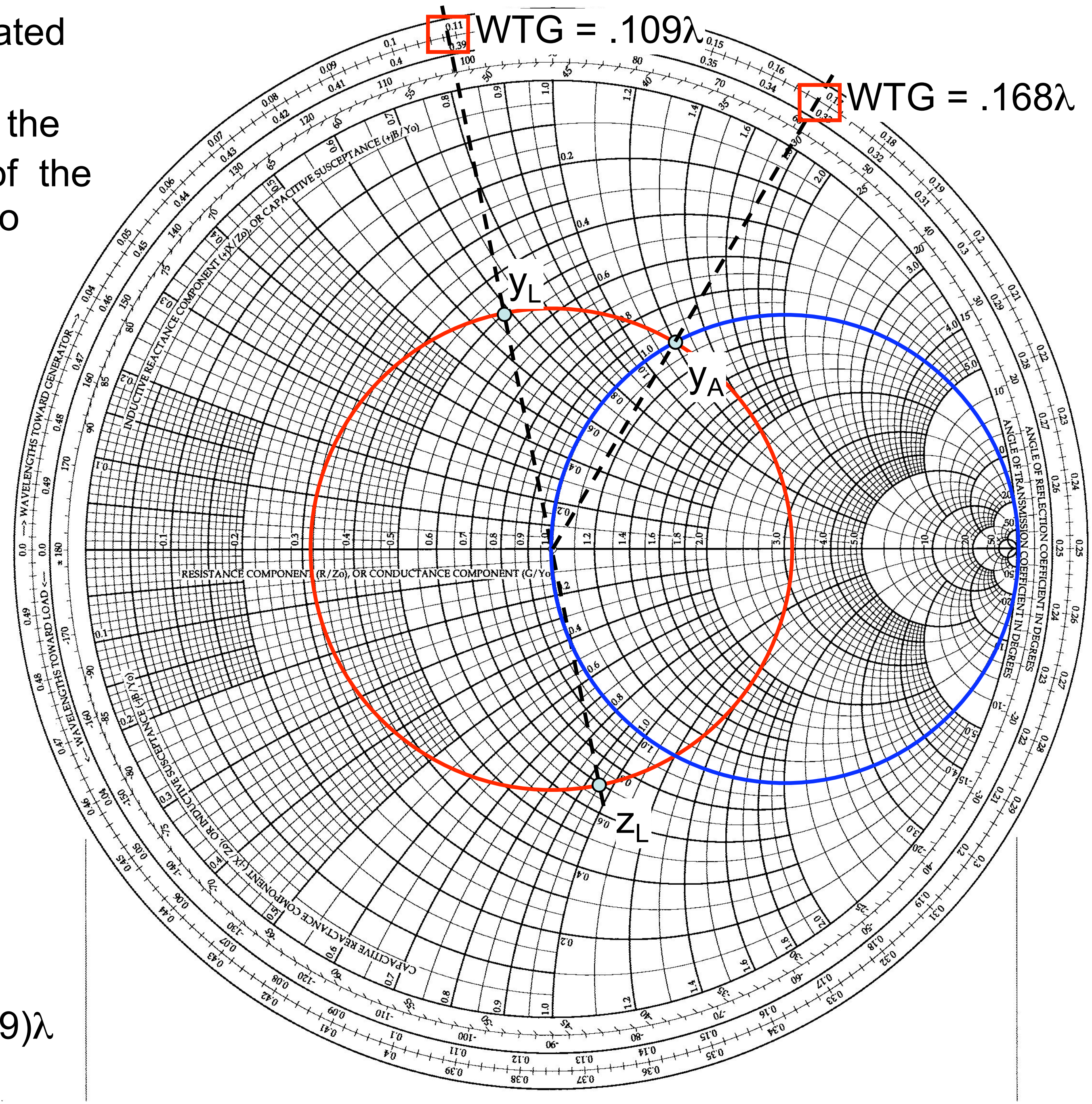
4) Find b_{STUB}

5) Rotate towards load until stub termination is reached (L_{STUB})



A 50-Ω T-L is terminated in an impedance of $Z_L = 35 - j47.5$. Find the position and length of the short-circuited stub to match it.

1) Normalize Z_L
   $z_L = 0.7 - j0.95$
2) Find z_L on S.C.
3) Draw Γ circle
4) Convert to y_L
5) Find g=1 circle
6) Find intersection of Γ circle and g=1 circle (y_A)
7) Find distance traveled (WTG) to get to this admittance
8) This is d_{STUB}
   $d_{STUB} = (.168-.109)\lambda$
   $d_{STUB} = .059\lambda$



A 50-Ω T-L is terminated in an impedance of $Z_L = 35 - j47.5$. Find the position and length of the short-circuited stub to match it.

9) Find b_A

10) Locate P_{SC}

11) Set $b_{STUB} = b_A$ and find $y_{STUB} = -jb_{STUB}$

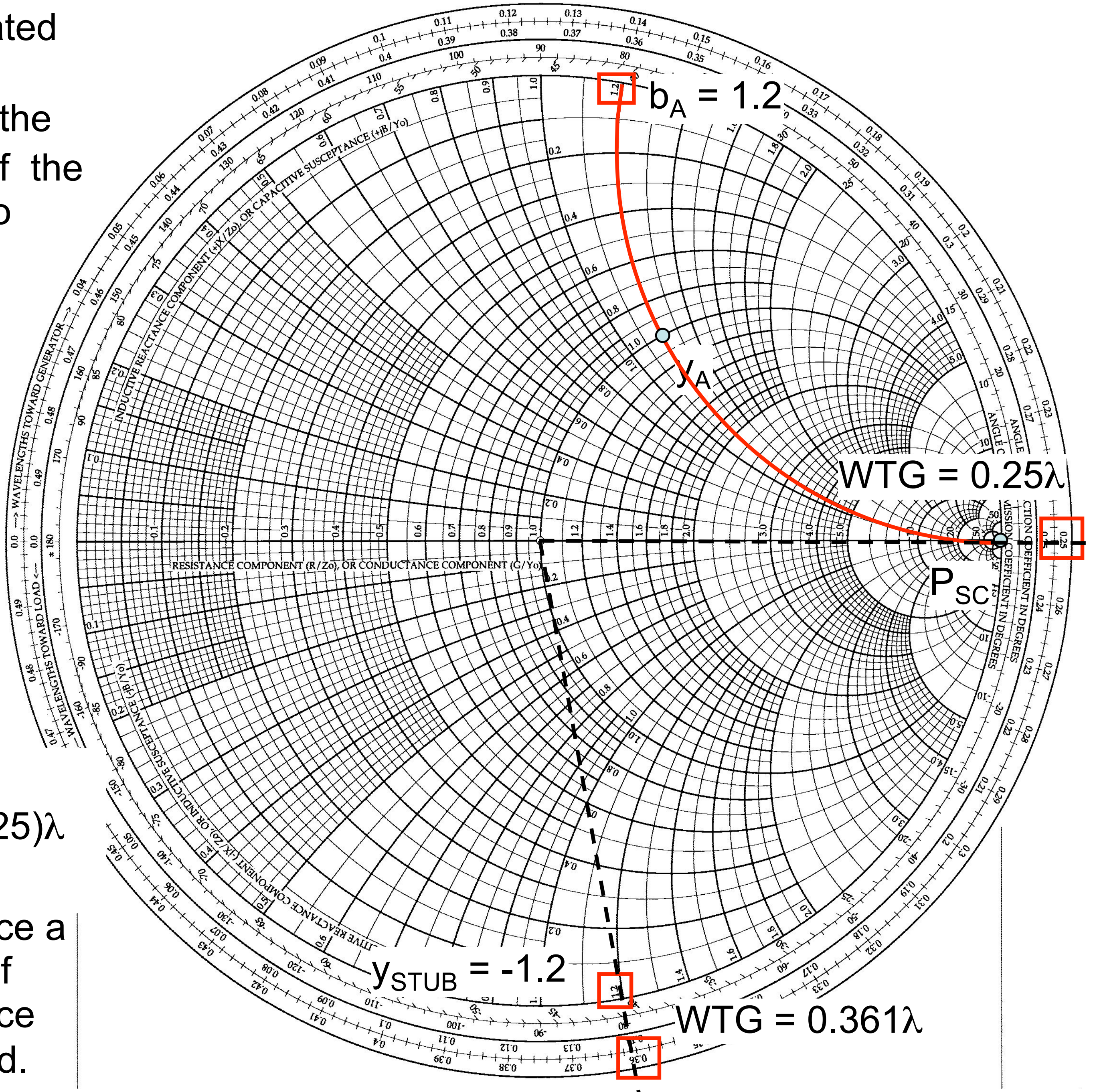
12) Find distance traveled (WTG) to get from P_{SC} to b_{STUB}

13) This is L_{STUB}

$L_{STUB} = (0.361-0.25)\lambda$

$L_{STUB} = .111\lambda$

Our solution is to place a short-circuited stub of length $.111\lambda$ a distance of $.059\lambda$ from the load.



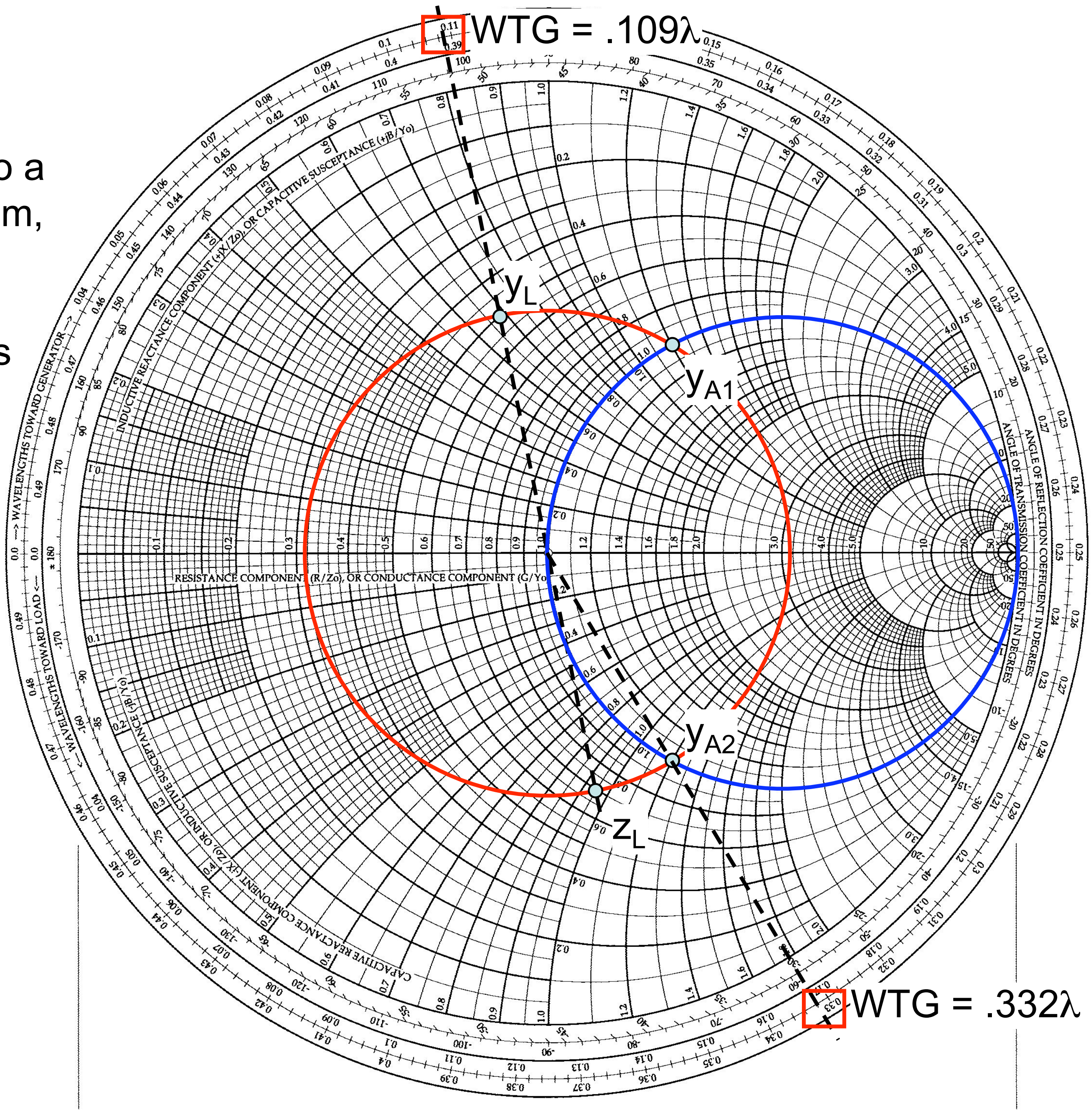
There is a second solution where the Γ circle and g=1 circle intersect. This is also a solution to the problem, but requires a longer d_{STUB} and L_{STUB} so is less desirable, unless practical constraints require it.

$d_{STUB} = (.332 - .109)\lambda$

$d_{STUB} = .223\lambda$

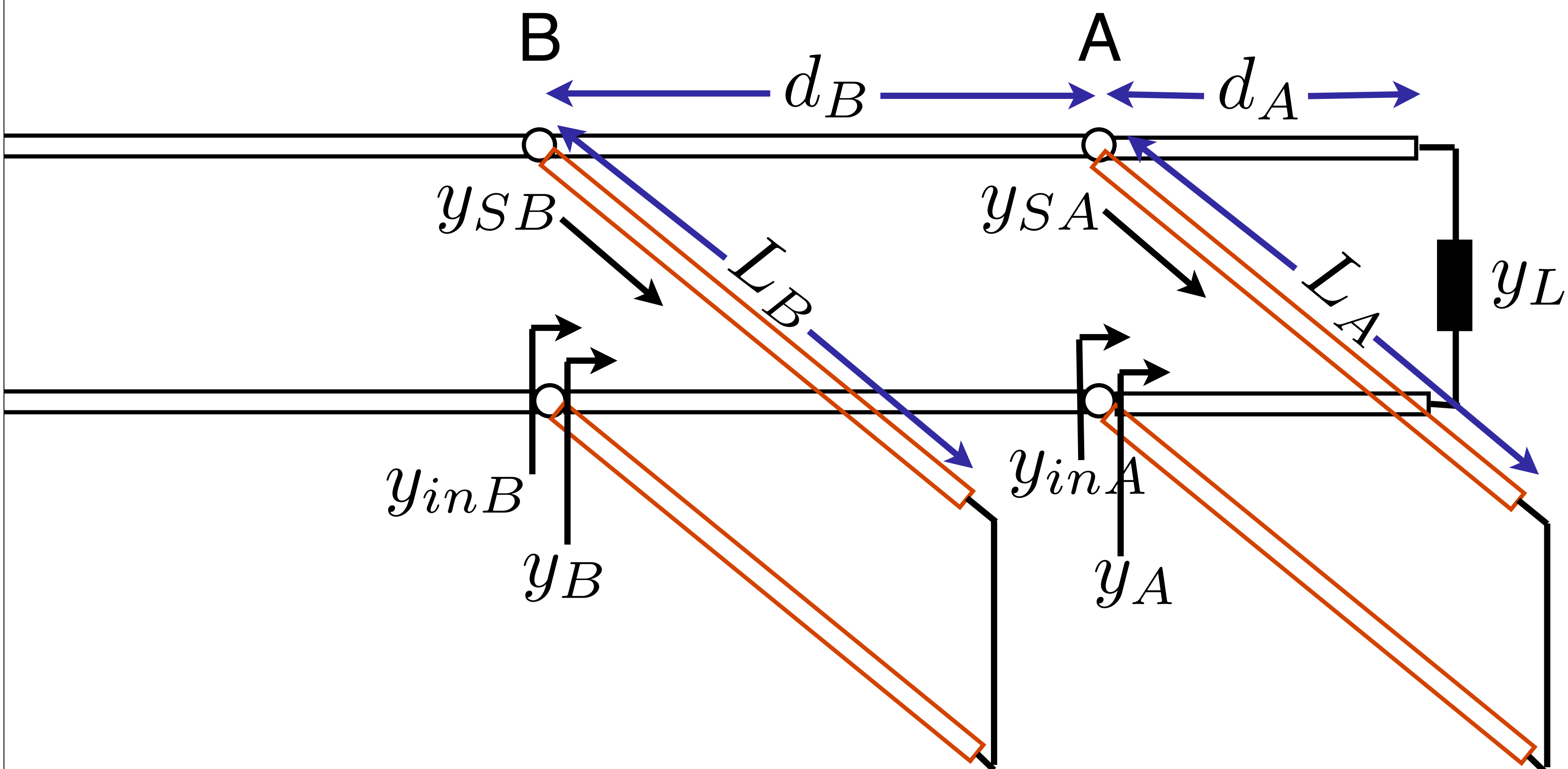
$L_{STUB} = (.25 + .139)\ \lambda$

$L_{STUB} = .389\ \lambda$



Double stub tuning

the goal still is to achieve a match, so $y_{inB} = 1 + j0$



Steps to Solve a Double-Stub Matching Problem

Goal: Design a double-stub matching network such that

$$Y_{IN,A} = Y_0$$

1) Convert the load to a normalized admittance: $y_L = g + jb$
2) Transform y_L along constant Γ *towards generator* by distance d_A to reach $y_A = g_A + jb_A$
3) Draw auxillary circle (pivot of g=1 circle by distance d_B)
4) Add susceptance (b) to y_A to get to $y_{IN,A}$ on auxillary circle. The amount of susceptance added is equal to $-b_{SA}$, the input susceptance of stub A.
5) Find $y_{SA} = -jb_{SA}$ Determine L_A by transforming y_{SA} along constant Γ *towards load* until we reach P_{SC} (for short-circuit stub) or P_{OC} (for open-circuit stub).
6) Transform $y_{IN,A}$ along constant Γ *towards generator* by distance d_B to reach y_B on auxillary circle. The susceptance of y_B (b_B) is equal to $-b_{SB}$, the input susceptance of stub B.
7) Find $y_{SB} = -jb_{SB}$ Determine L_B by transforming y_{SB} along constant Γ *towards load* until we reach P_{SC} (for short-circuit stub) or P_{OC} (for open-circuit stub).

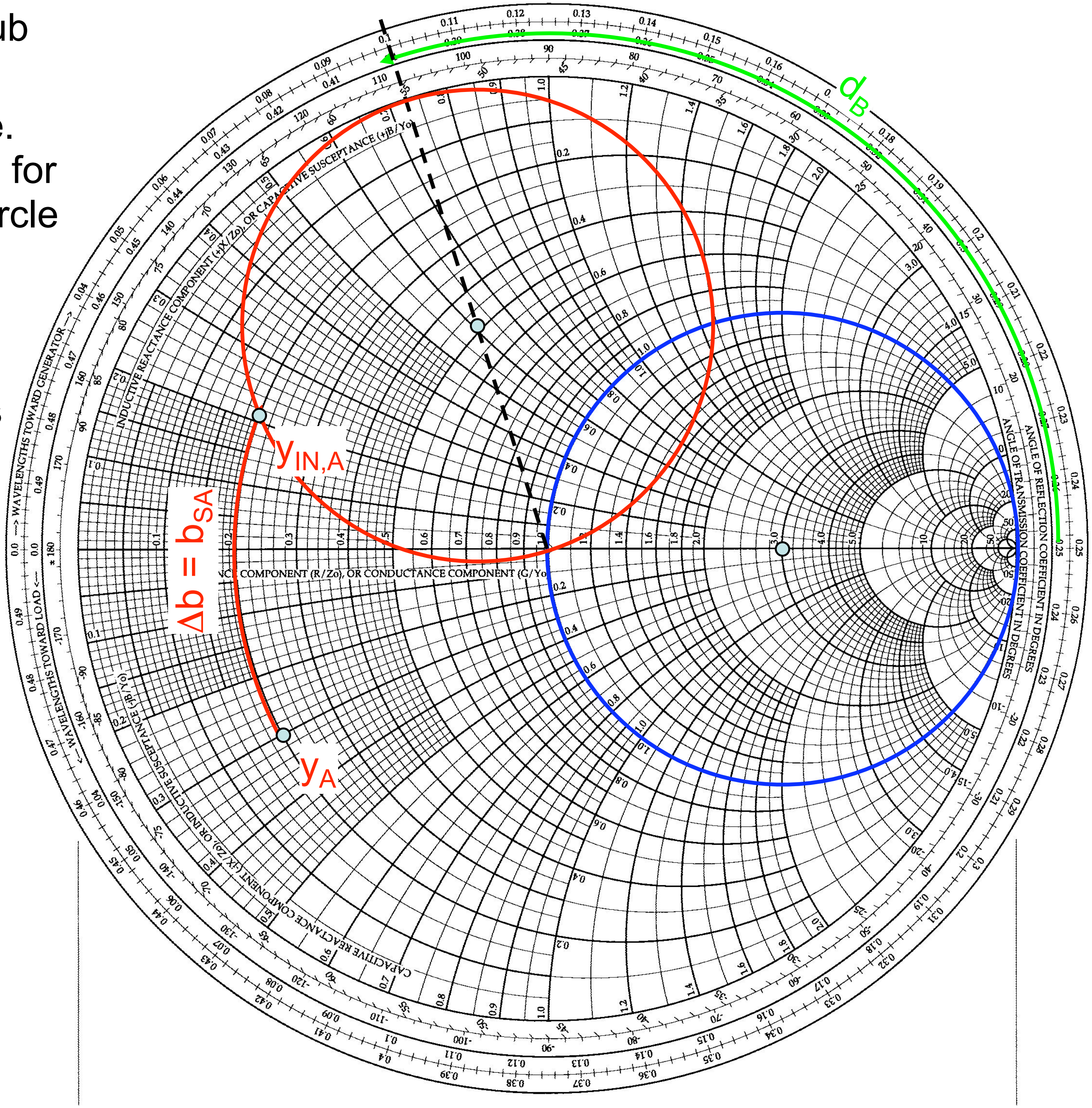
To solve a double-stub tuner problem:

1) Find the g=1 circle. All possible solutions for y_B must fall on this circle

2) Rotate the g=1 circle a distance d_B towards the load. These are the values at the input to the A junction that will transform to the g=1 circle at junction B

3) Find y_A on chart

4) Rotate along the constant g circle to find the intersection with the rotated g=1 circle. The change in b to do this is the susceptance at the input to the stub at junction A

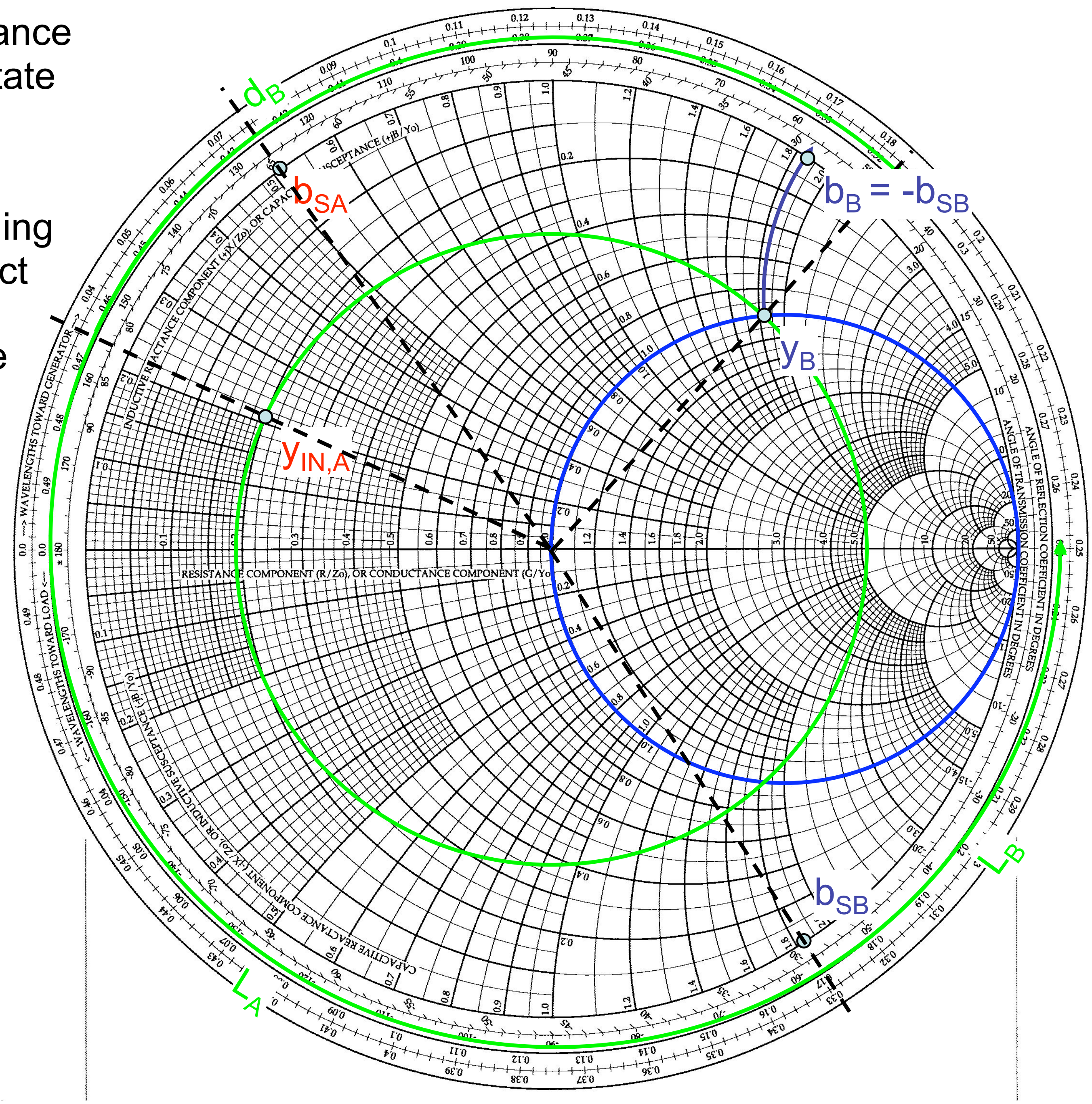


5) To find the admittance at junction B (y_B), rotate $y_{IN,A}$ towards the generator by d_B. If we've drawn everything right, this will intersect the g=1 circle.

6) Read off the value for b_B. This is $-b_{SB}$ for the stub at junction B

6) Calculate the length of the B stub by rotating towards the load from b_{SB} to the appropriate stub termination (P_{SC} or P_{OC})

6) Calculate the length of the A stub in the same way starting from b_{SA}



Similar to the single-stub network, there are multiple lengths for the stubs that will work.

There is a range of y_A that cannot be matched Irregardless of the short/open stub properties, we will never intersect the rotated g=1 circle.