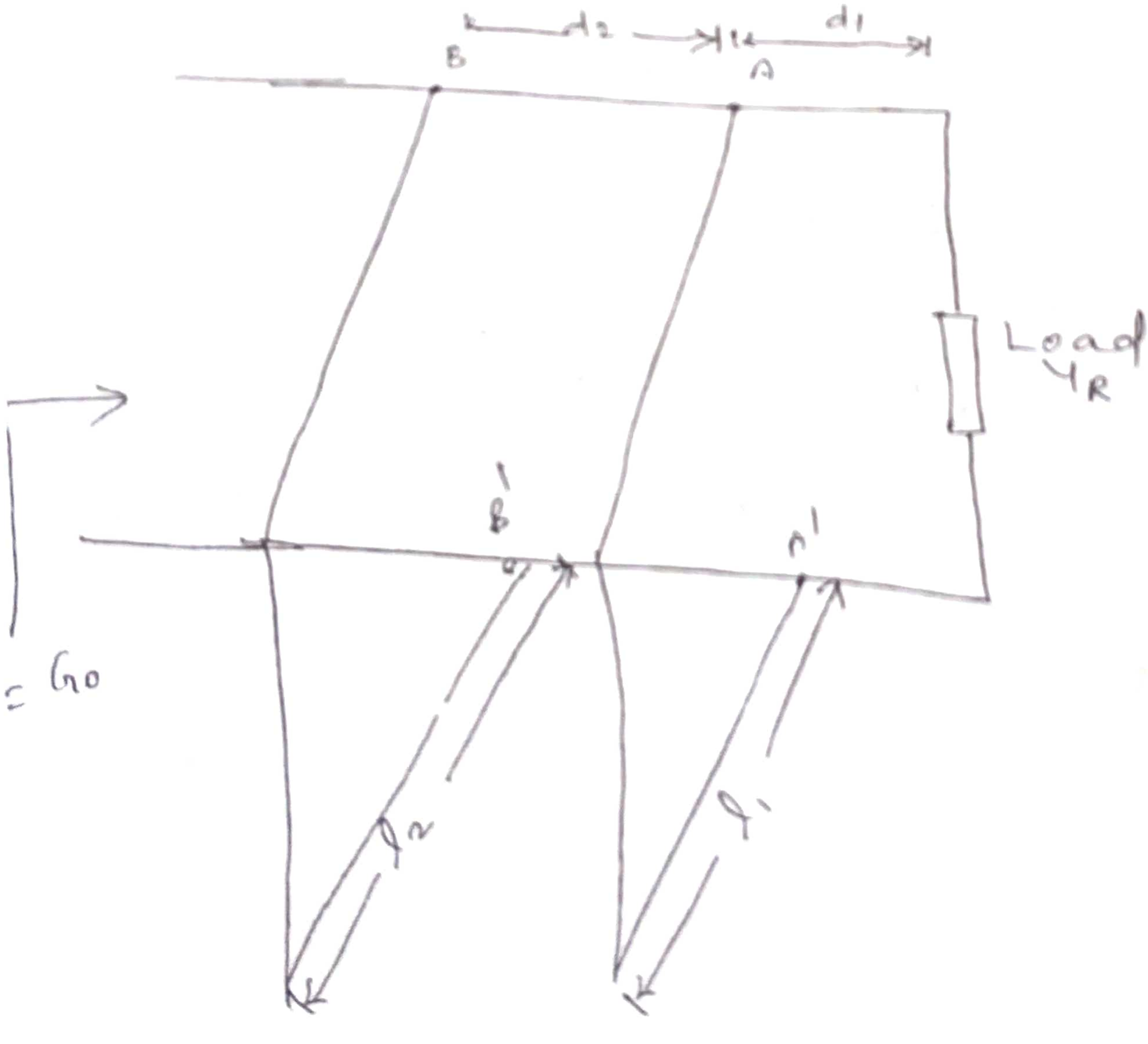
DOUBLE STUB MATCHING

Draw backs of single stub matching

i) single stub matching is applicable for single frequency. For variable frequency, the location of the stub is changing

ii) For final adjustment, the stub has to be moved along the line. It is possible for open wire line and it is difficult for coaxial line.

To avoid these disadvantages, double stub matching is introduced. In this technique two different short circuited stubs of lengths l_1 and l_2 are used for impedance matching



(FIG) Double stub matching

Let stub 1 is located at A-A' a distance d_1 from the load. Let the length of stub 1 is l_1. Similarly stub of length l_2 is located at points B-B' at distance d_2 away from stub 1.

The input impedance of a dissipationless line at any point distance s away from the load is given by,

$$Z_s = Z_0\left[\frac{Z_R + jZ_0\tan\beta s}{Z_0 + jZ_R\tan\beta s}\right] \rightarrow (1)$$

Subs $Z_s = \frac{1}{Y_s}$, $Z_0 = \frac{1}{Y_0}$, $Z_R = 1/Y_R$

$$\frac{1}{Y_s} = \frac{1}{Y_0}\left[\frac{\frac{1}{Y_R} + j\frac{1}{Y_0}\tan\beta s}{\frac{1}{Y_0} + j\frac{1}{Y_R}\tan\beta s}\right]$$

$\times$ by Y_R

$$\frac{Y_0}{Y_s} = \left[\frac{1 + j\frac{Y_R}{Y_0}\tan\beta s}{\frac{Y_R}{Y_0} + j\tan\beta s}\right]$$

Inverting

$$\frac{Y_s}{Y_0} = \left[\frac{\frac{Y_R}{Y_0} + j\tan\beta s}{1 + j\frac{Y_R}{Y_0}\tan\beta s}\right] \rightarrow (2)$$

$\frac{Y_s}{Y_0} = y_s$ = Normalized input impedance.

$$y_s = \frac{y_R + j\tan\beta s}{1 + j y_R\tan\beta s} \rightarrow (3)$$

Rationalizing eq (2)

$$y_s = \frac{y_R + j\tan\beta s}{1 + j y_R \tan\beta s} \times \frac{1 - j y_R \tan\beta s}{1 - j y_R \tan\beta s}$$

$$= \frac{y_R - j y_R^2 \tan\beta s + j\tan\beta s + y_R \tan^2\beta s}{1 + y_R^2 \tan^2\beta s}$$

$$y_s = \frac{y_R(1+\tan^2\beta s)}{1 + y_R^2\tan^2\beta s} + \frac{j(1-y_R^2)\tan\beta s}{1+y_R^2\tan^2\beta s} \rightarrow (4)$$

Stub 1 is located at point A-A' at a distance $s=d_1$ from the load. Hence substituting the value of s as d_1 in eq (4), we get.

$$y_s = \frac{y_R(1+\tan^2\beta d_1)}{(1+y_R^2\tan^2\beta d_1)} + \frac{j(1-y_R^2\tan\beta d_1)}{(1+y_R^2\tan^2\beta d_1)} \rightarrow (5)$$

$$= g_i + j b_1$$

when a stub-1 having a susceptance $\pm j b_1$ is added at this point, the new admittance will be,

$$y_s' = g_i + j b_i'$$

Since the input admittance of a short circuited stub is purely imaginary. The conductance ~~of the~~ of the new admittance y_s' will remain unchanged.

Here $b_i' = b_i \pm b_1$.

Now the input admittance of the line at point B-B' should be equal to Go

So that the line appears to be terminated into its characteristic impedance.

The point B-B' should be located such that normalized admittance at this point is given by

$$y_B' = \frac{y_s}{G_o} = 1 \pm jb_2.$$

Then finally, the length of stub 2 is adjusted such that susceptance of stub 2 $\mp jb_2$ resonates with susceptance jb_2 at point 2-2' and the desired admittance is 1 at B-B'.

The spacing between the stubs should not be more than or equal to λ_2 because the input admittance repeats after every $\lambda/2$ distance.

It may be $\lambda/16$, $\lambda/8$, $3\lambda/16$, $\frac{3\lambda}{8}$ ...

The most common seperations are $\lambda/4$ & $\frac{3\lambda}{8}$.

Advantages of short circuited stub compared to open circuited stub

A short circuited stub is normally preferred than open circuited stub because of

(i) its simpler construction
(ii) ~~a~~ open circuited stubs radiates ~~at~~ from its open ends.

The short circuited stub can be easily established with a large metal plate and it also has a lower radiation loss of energy.