SNS COLLEGE OF ENGINEERING

(Autonomous)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

19EC502 – TRANSMISSION LINES AND ANTENNAS

III YEAR/ V SEMESTER

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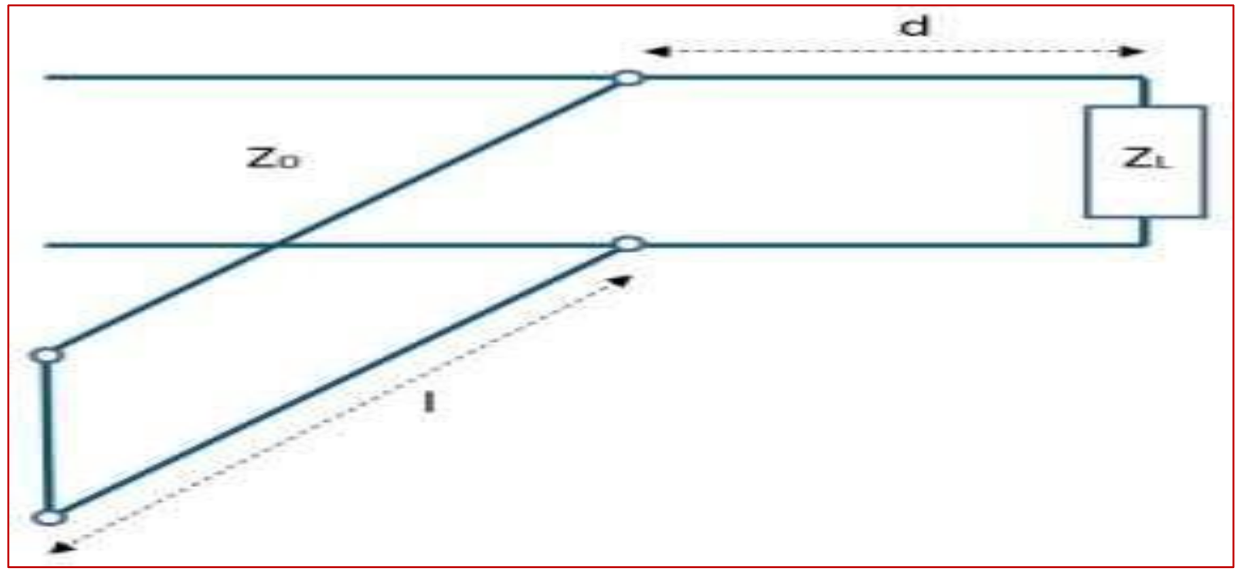
UNIT 1 – TRANSMISSION LINE THEORY

TOPIC – DOUBLE STUB MATCHING

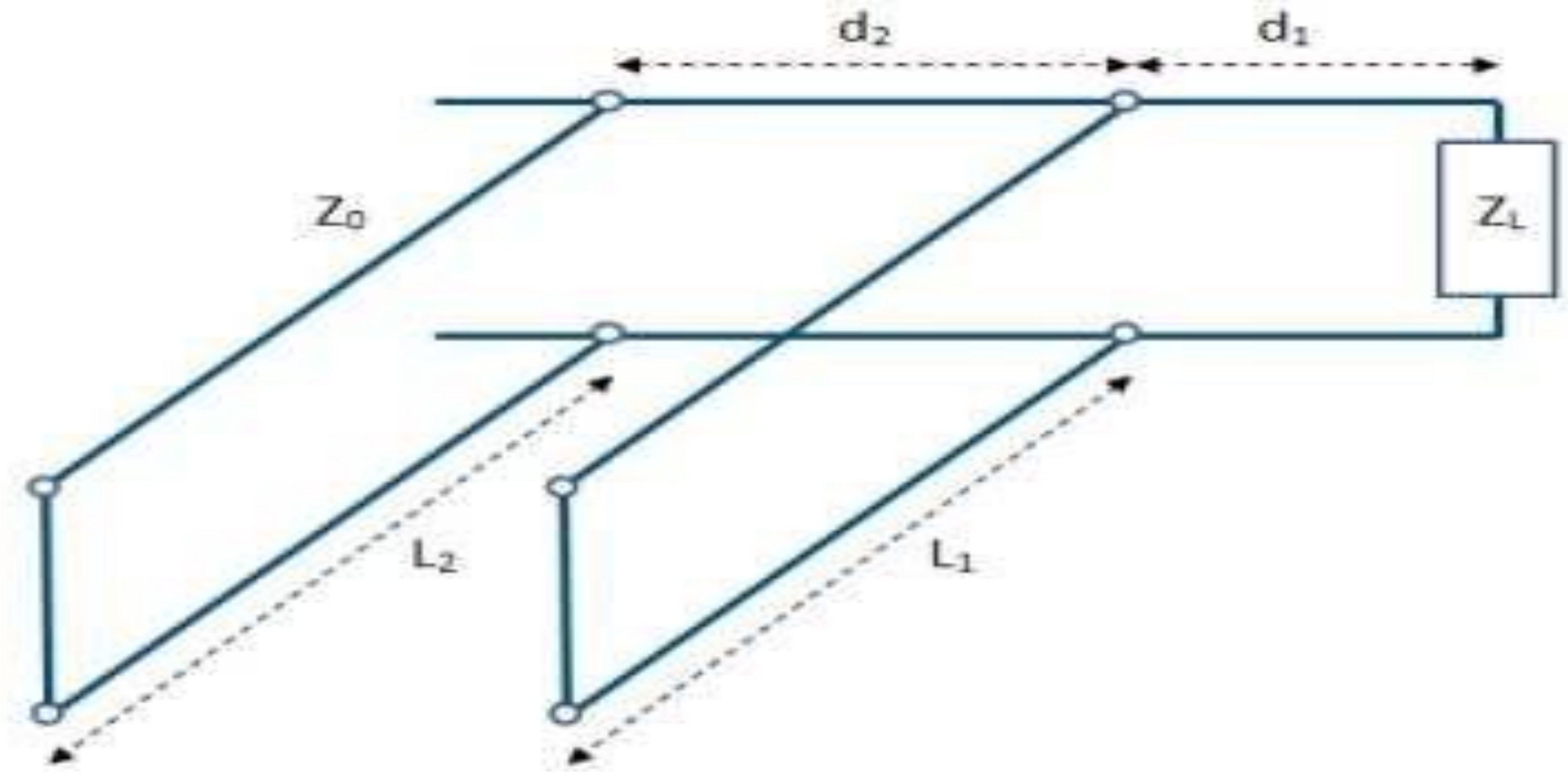
DISADVANTAGES OF SINGLE STUB MATCHING

- Single stub matching is applicable for single frequency
- 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 overcome the drawbacks of the single-stub matching technique, the double-stub matching technique is employed



DOUBLE STUB MATCHING

- Two short circuited stubs of length l_1 and l_2 are used
- Stub 1 of length l_1 is located at a distance d_1 from the load
- Similarly stub 2 of length l_2 is located at a distance d_2 from stub 1



DOUBLE STUB MATCHING - PRINCIPLE

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

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

Interms of admittances, subs.

$Z_s = \frac{1}{Y_s}$, $Z_0 = \frac{1}{Y_0}$ & $Z_R = \frac{1}{Y_R}$ in eq (1)

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

DOUBLE STUB MATCHING - PRINCIPLE

Multiply by Y_R in both Nr & Dr of R.H.S

$$\frac{Y_0}{Y_S} = \left[\frac{1 + \frac{Y_R}{Y_0} \tan \beta s}{\frac{Y_R}{Y_0} + j \tan \beta s}\right] \rightarrow (3)$$

Inverting eq (3),

$$\frac{Y_S}{Y_0} = \frac{\frac{Y_R}{Y_0} + j \tan \beta s}{1 + \frac{Y_R}{Y_0} \tan \beta s} \rightarrow (4)$$

subs $\frac{Y_S}{Y_0} = y_s \rightarrow$ Normalized input impedance & $\frac{Y_R}{Y_0} = y_R \rightarrow$ Normalized load impedance

in eq (4)

DOUBLE STUB MATCHING - PRINCIPLE

$$y_s = \frac{y_R + j\tan\beta s}{1 + j y_R \tan\beta s} \rightarrow (5)$$

Rationalizing eq (5)

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

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

$$\therefore \quad y_s = \frac{y_R(1 + \tan^2\beta s)}{1 + y_R^2 \tan^2\beta s} + j\frac{(1 - y_R^2)\tan\beta s}{1 + y_R^2 \tan^2\beta s} \rightarrow (6)$$

DOUBLE STUB MATCHING - PRINCIPLE

stub 1 is located at point A - A' at a distance $s = d_1$ from the load.

$\therefore$ Subs $s = d_1$ in eq (6),

$$y_s = \frac{y_R(1+\tan^2\beta d_1)}{1+y_R^2\tan^2\beta d_1} + \frac{j(1-y_R^2)\tan\beta d_1}{1+y_R^2\tan^2\beta d_1} \rightarrow (7)$$

$$y_s = g_i + j b_i$$

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

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

where $b_i' = b_i \pm b_1$

DOUBLE STUB MATCHING - PRINCIPLE

At B–B', the normalized admittance is given by,

$$y_B' = \frac{y_s}{G_0} = 1 \pm j b_2$$

The stub 2 is adjusted such that the susceptance of stub 2 is $\mp j b_2$.

So the new admittance at B–B' is

$$y_s' = 1 \pm j b_2 \mp j b_2$$

$$y_s' = \frac{y_s}{G_0} = 1$$

$$\therefore y_s = G_0$$

$$\boxed{Z_s = R_0}$$

This is the required condition.

DOUBLE STUB MATCHING - PRINCIPLE

- The spacing between the stubs should not be more than or equal to $\lambda/2$.

It may be,

$\lambda/16$, $\lambda/8$, $3\lambda/16$, $\frac{3\lambda}{8}$

The most common seperations are

$\lambda/4$ & $3\lambda/8$

DOUBLE STUB MATCHING - PROBLEM

- For a load of Z_R/Z_0 = 0.8 + j 1.2. Design a double stub tuner making the distance between the two stubs 3λ/8. Specify the stub length and distance from the load to the first stub. The stubs are short circuited. Verify using Smith Chart

DOUBLE STUB MATCHING - PROBLEM

- **Step 1 :**

Finding normalized admittance from the given normalized impedance

$Z_R/Z_0 = 0.8 + j\,1.2$

Rationalizing

$Y_R/G_0 = 0.8 - j\,1.2 \;/\; 2.08$

$= 0.4 - j\,0.6$

Mark the point on the chart

DOUBLE STUB MATCHING - PROBLEM

Step 2 :

Trace the unity circle on the chart (the circle passes through real value 1 of the horizontal axis)

Step 3:

Draw a circle which lies between point 1 on the horizontal axis and the reactance value 0.375 λ. (3 λ/8 circle)

Step 4 :

Move the line from normalized admittance without changing the real value. It cuts the 3 λ/8 circle at a point 0.4-j0.2. This is the point where stub 1 is connected

DOUBLE STUB MATCHING - PROBLEM

Step 5 :

Find the difference between the susceptance. The new susceptance is j0.6-j 0.2 = j0.4. Draw a line which passes through j0.4. From the short circuit end to the point of stub connection 1 is the distance d1

Step 6:

Find the susceptance value at a point where unity circle cut with another circle has radius of centre point to stub 1 connection point

Step 7 :

The susceptance value at that point is +j1. Find the opposite susceptance -j1. This is the point where stub 2 is connected. The distance between stub 1 connection point and stub 2 connection point is the distance d2

DOUBLE STUB MATCHING - PROBLEM