Week 4: - Attenuators

Attenuators:

- Attenuator is a four terminal network, inserted between an input and output.
- It produces a specific amount of loss for current and voltage.

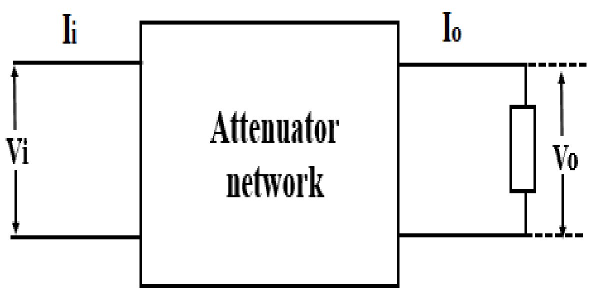


Figure shows the attenuator circuit where,

Vo →Output voltage in volts, Vi →Input voltage in volts

Io →Output current in amps, Ii →Input current in amps

Po→Power output in watts, Pi→Power input in watts

Classification of attenuators: Attenuators can be classified as

1. **Symmetrical attenuator:**

   It is resistive network installed between source and load having equal input and output resistance.

   Symmetrical attenuator is further classified as:

   i) T type

   ii) Π type

2. **Asymmetrical attenuator:**

   It is resistive network installed between source and load having unequal input and output resistance.

3. **Fixed attenuator:**

   Fixed attenuator provides fixed amount of attenuation. It is also called as pad.

4. **Variable attenuator:**

   Variable attenuator are attenuators whose attenuation can be varied.

Applications of attenuator: Attenuators are used

- In radio communication and transmission line to weaken a stronger signal.
- As volume controls in broadcasting stations
- For matching circuits
- To enhance the input impedance of equipment or instruments.

Bel, Decibel and Neper:

Decibel: Decibel (dB):

- Decibel is unit for expressing the ratio between two physical quantities like acoustic or electrical power or loudness of sounds.
- One decibel equals 10 times the common logarithm of the power ratio.

Decibel (dB) = 10 log (P_2/P_1)

Where, $\frac{P2}{P1}$ represents power ratio.

Bel(B):

- Bel is a unit used for measuring sound intensity equal to 10 decibels.
- One Bel equals logarithm of the power ratio.

Bel (B) = log (P_2/P_1)

Where, $\frac{P2}{P1}$ represents power ratio.

Neper:

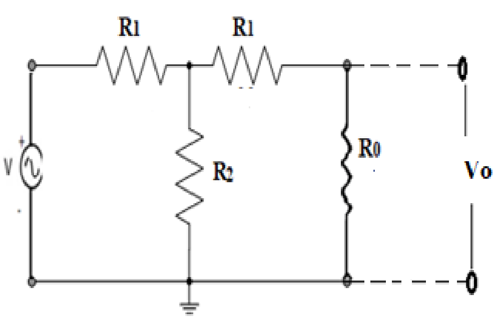
- Neper is unit for expressing the ratio between two physical quantities like acoustic or electrical power or loudness of sounds.
- Neper is natural logarithm of the power ratio.

Neper = ln (P_2/P_1)

Where, $\frac{P2}{P1}$ represents power ratio.

- 1Neper =8.68dB.

Symmetric T attenuator: The symmetrical T-type attenuator is as shown below

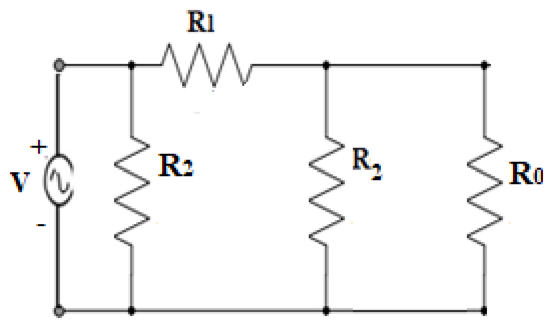


$R_1 = R_0 *(N-1) / (N+1)$

$R_2 = R_0 *2N / (N^2 -1)$

Where, N is attenuation factor

Symmetric π attenuator: The symmetrical T-type attenuator is as shown below



$R_1 = R_0 *(N+1) / (N-1)$

$R_2 = R_0 *(N^2-1) / 2N$

Where, N is attenuation factor

Problems:

1. Design a T-type pad to give 25dB attenuation and to have characteristic impedance of 600 ohms.

   Solution: Given, attenuation D = 25dB, R_0 = 600ohms

   $D = 20\log N$

   $\log N = D/20 = 25/20$

   $N= \text{antilog } (25/20) =10^{(25/20)}$

   $N=17.78$

w.k.t. $R_1 = [R_0 *(N-1)] / (N+1)$

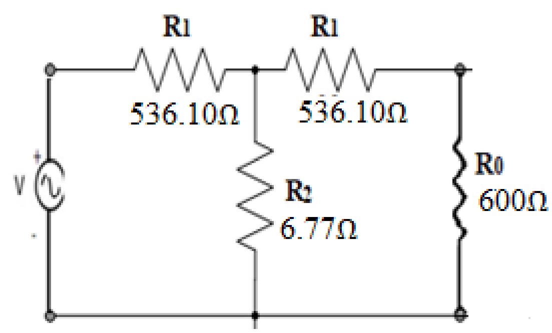
$R_1 = [600 * (17.78 -1)] / (17.78 +1)$

$R_1 = 536.10\Omega$

$R_2 = [R_0 *2N] / (N^2 -1)$

$R_2 = [600* 2*17.78] / (17.78^2 -1)$

$R_2 = 6.770\Omega$



2. Design a π-type symmetrical attenuator to be inserted between 600Ω for an attenuation of 10dB.

Solution: Given, attenuation D = 10dB, R_0 = 600ohms

$D = 20\log N$

$\log N = D/20 = 10/20$

$N = \text{antilog}(10/20) = 10^{(10/20)}$

$N = 3.162$

w.k.t. $R_2 = [R_0 * (N+1)] / (N-1)$

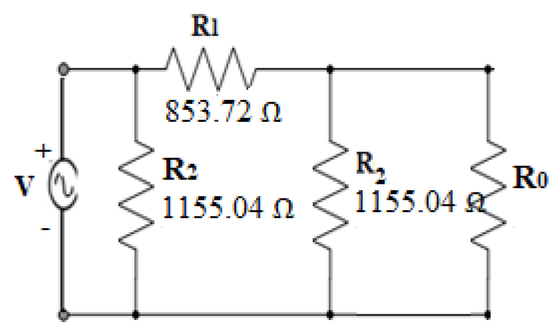
$R_2 = [600 * (3.162 + 1)] / (3.162 - 1)$

$R_2 = 1155.04\ \Omega$

$R_1 = (N^2 - 1) / [R_0 * 2N]$

$R_1 = (3.162^2 - 1) / [600 * 2 * 3.162]$

$R_1 = 853.72\ \Omega$



Activity:

1. An item in telecom system has an input resistance of 600Ω and correctly terminated. When an input voltage of 1.5 V is applied a current of 15mA flows in the load. Calculate the loss or gain of the system.

2. Design a T-type pad to give 10dB attenuation and to have characteristic impedance of 600 ohms.