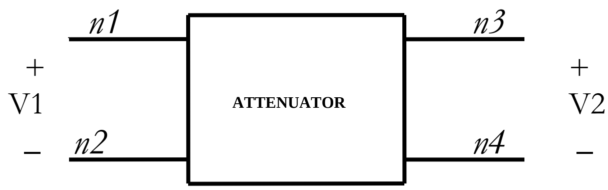
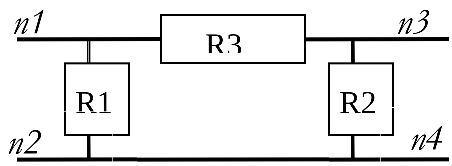
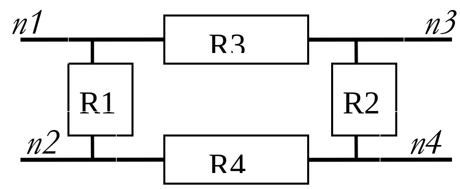


Three Terminal



Four Terminal



Description:

This element implements an attenuator using a resistor network. Three and Four terminals resistive attenuators are implemented. Four terminals must be specified in the netlist and the Three terminal implementation is used if the second and fourth terminals are the same.

The term attenuation, usually used in high frequency techniques, is defined as the ratio, expressed in decibels, of the power level or voltage level between two points in a circuit. The attenuation of a component under test will be the ratio, expressed in decibels, of the power absorbed by the load without the component in the line to the power absorbed by the load with the component in the line, when the signal source and the load are perfectly matched.

Attenuation A = 10 $\log_{10}$ (P1/P2) db or 10 $\log_{10}$ (V1/V2) db

P1 = power absorbed by the load without the component in the line
P2 = power absorbed by the load with the component in the line
V1 = input voltage
V2 = output voltage

Form:

attenuator:<instance name> n_1 n_2 n_3 n_4 <parameter list>
n_1 is the port #1 signal input terminal
n_2 is the port #1 reference terminal
n_3 is the port #2 signal output terminal
n_4 is the port #2 reference terminal (can be the same as n_2)

Parameters

Example

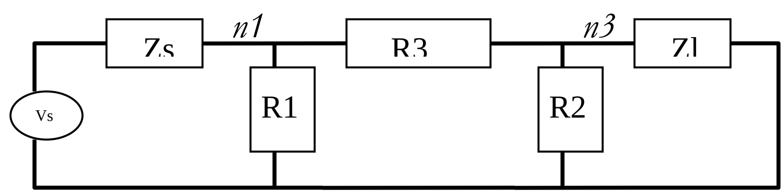
attenuator:a1 1 0 3 0 zo=50 alpha=2

attenuator:a1 1 0 3 4 zo=50 alpha=2

Parameter	Type	Default Value	Required?
Zo: characteristic impedance	DOUBLE	50	yes
alpha: attenuation constant	DOUBLE	N/A	yes

Model Documentation

Consider the following 3 terminal network when n2=n4 and derive the stamp:



Zs- source impedance
Zl- load impedance

Assuming Zs=Zl = Zo

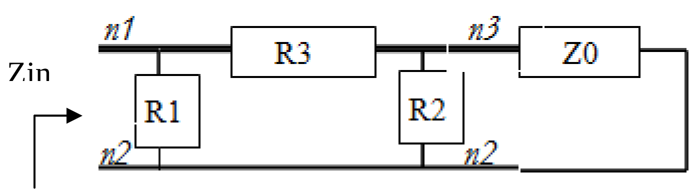


Fig.1

$R1 \parallel (R3+(R2 \parallel Zo)) = Zo$ (……a)

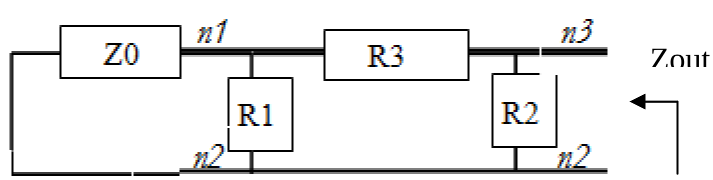


Fig.2

$R2 \parallel (R3+(R1 \parallel Zo)) = Zo$ (……b)

Solving 'a' and 'b' we get R1=R2

Now

alpha = 10 log(P1/P2) db

where $P1 = V_1^2/(2Zo)$ and $P2 = V_2^2/(2Zo)$

therefore

alpha = 20 $\log(V_1/V_2)$ db

$k= V_1/V_2 = 10$ (alpha/20) (……..c)

Applying KCL at node n1 and n3:

$V_1/Zo = V_1/R1 + (V_1-V_2)/R3$ (…….d)

$(V_1-V_2)/R3 = V_2/R2 + V_2/Zo$ (…….e)

Combining 'c' and 'd':

$V_1/Zo = V_1/R1 + V_2/R1 + V_2/Zo$ (…….f)

Eliminating V2 and using equation 'c':

k-1/Zo = k+1/R1

R1 = R2 = Zo(k+1)/(k-1)

Using equation 'e':

R3 = Zo(k^2-1)/(2k)

Therefore, g1=1/R1; g2=1/R2; g3=1/R3

We obtain the final stamp of the matrix as given below:

$$\begin{array}{c|ccc|}
 & 1 & 2 & 3 \\
1 & g1+g3 & -g1 & -g3 \\
2 & -g1 & g1+g2 & -g2 \\
3 & -g3 & -g2 & g2+g3
\end{array}$$

The stamp of the 4 terminal network is obtained on the similar lines as the 3 terminal network.

$$
\begin{array}{c|cccc|}
 & 1 & 2 & 3 & 4 \\
\hline
1 & g1+g3 & -g1 & -g3 & 0 \\
2 & -g1 & g1+g4 & 0 & -g4 \\
3 & -g3 & 0 & g2+g3 & -g2 \\
4 & 0 & -g4 & -g2 & g2+g3
\end{array}
$$

g1=1/R1; g2=1/R2; g3=1/R3; g4=1/R4

R1 = R2 = Zo(k+1)/(k-1)

R3 = R4 = Zo(k^2-1)/(4k)

Version: 1

Credits:

Name	Affliation	Date	Links
Shravanthi Ippagunta sippagu@ncsu.edu	NC State University	April 24 2008	www.ncsu.edu
Michael Steer mbs@ncsu.edu	NC State University	April 28 2008	www.ncsu.edu