# Directional Coupler Analysis

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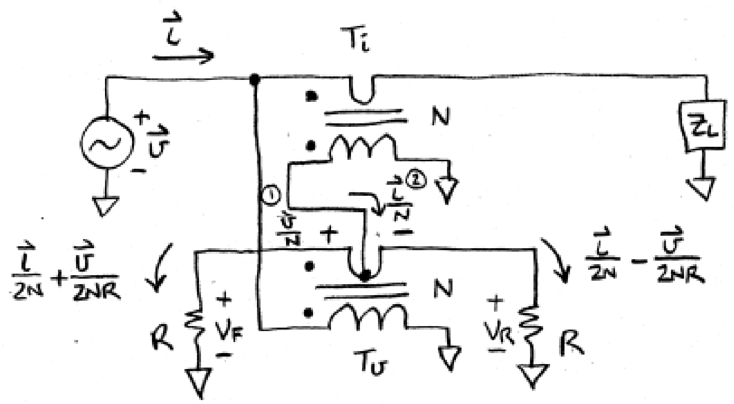
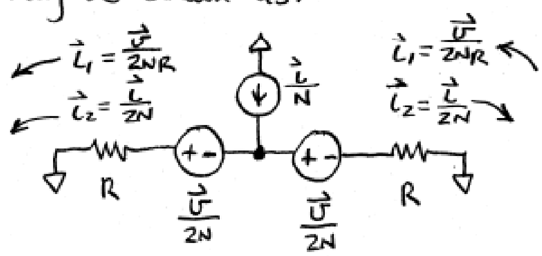



① because of voltage transformer $T_v$

② because of current transformer $T_i$

R circuit may be drawn as:




Current through each R is superposition of $i$-source and $v$-source currents as shown. Case 1: $i$-source $= 0$, case 2: $v$-sources $= 0$. Superposing resulting voltages:

$$\vec{V}_F = \frac{\vec{i}R + \vec{v}}{2NR}$$
$$\vec{V}_R = \frac{\vec{i}R - \vec{v}}{2NR}$$

instantaneous, vector values

Now if current is + leaving source and voltages are referred to ground, the total line current and voltage $\vec{i}$ and $\vec{v}$ may be separated into forward and reverse components:

$$\vec{i} = \vec{i}_F - \vec{i}_R$$
$$\vec{v} = \vec{v}_F + \vec{v}_R$$

So we have

$$\vec{V}_F = \frac{(\vec{i}_F - \vec{i}_R)R + (\vec{v}_F + \vec{v}_R)}{2NR}$$

$$\vec{V}_R = \frac{(\vec{i}_F - \vec{i}_R)R - (\vec{v}_F + \vec{v}_R)}{2NR}$$

and if $R = Z_0 = \frac{\vec{v}_F}{\vec{i}_F} = \frac{\vec{v}_R}{\vec{i}_R}$ = line characteristic impedance, then

$$\vec{V}_F = \frac{(\vec{v}_F - \vec{v}_R) + (\vec{v}_F + \vec{v}_R)}{2NR} = \frac{\vec{v}_F}{NR} = \frac{\vec{i}_F}{N}$$

$$\vec{V}_R = \frac{(\vec{v}_F - \vec{v}_R) - (\vec{v}_F + \vec{v}_R)}{2NR} = \frac{-\vec{v}_R}{NR} = \frac{-\vec{i}_R}{N}$$

These are instantaneous vector quantities, valid for any frequency or waveshape in the forward or reverse directions. They may be detected and scaled appropriately if the wave shape and load are known, to indicate forward and reverse power.