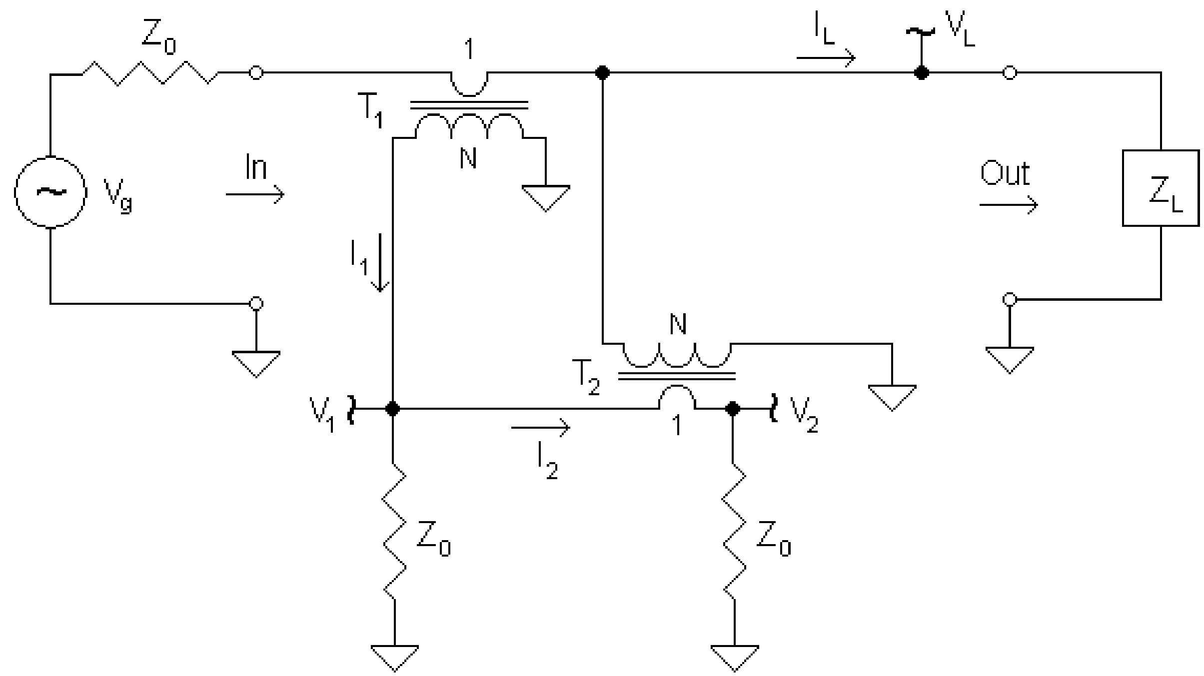
The Tandem Match Directional Coupler



Definitions (All quantities are phasors)

Reflection Coefficient $\Gamma = \dfrac{Z_L - Z_0}{Z_L + Z_0}$

Forward Voltage $V_f = \dfrac{V_L}{1 + \Gamma}$

Reflected Voltage $V_r = \dfrac{\Gamma V_L}{1 + \Gamma}$

Forward Current $I_f = V_f / Z_L$

Reflected Current $I_r = -V_r / Z_L$

If Z_L is the end of a transmission line, then these definitions coincide with the forward and reflected waves on the line.

Assumptions

The voltage drop across the 1-turn primary of T_1 is zero.

The current through the N-turn secondary of T_2 is zero.

From the definitions

$$V_L = V_f + V_r \quad \text{and} \quad I_L = I_f - I_r \quad \text{since} \quad I_L = V_L / Z_L$$

The voltage across the N-turn secondary of T_2 will be V_L, so the voltage across the 1-turn primary is

$$V_1 - V_2 = (1/N)\,V_L = (1/N)(V_f + V_r) \qquad (*)$$

The current through the 1-turn primary of T_1 is I_L, so the current through the N-turn secondary is

$$I_1 = (1/N)\,I_L = (1/N)(I_f - I_r)$$

We thus get another equation

$$V_1 + V_2 = (I_1 - I_2)Z_0 + I_2 Z_0 = I_1 Z_0 = (1/N)(I_f - I_r)Z_0$$

$$= (1/N)(V_f + V_r)(Z_0 / Z_L) \qquad (**)$$

Solving the simultaneous equations (*) and (**) for V_1 and V_2 gives

$$V_1 = (1/N)\,V_f \quad \text{and} \quad V_2 = -(1/N)\,V_r$$

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