Parallel Circuits

Parallel circuits are multiple-load circuits which have more than one path for current.

Each different current path is called a branch.

Current from the battery splits up among the three branches. The current and power in one branch are not dependent on the current, resistance, or power in any other branch.

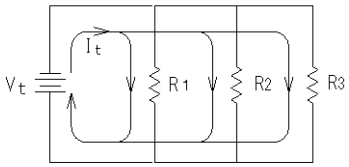

Fig.2 Example of a parallel circuit.

Voltage in Parallel Circuits

All voltages in a parallel circuit are the same. In other words, the source voltage appears across each branch of a parallel circuit.

For a parallel circuit, the relationship of source voltage to load voltage is expressed as

$$V_t = V_{R_1} = V_{R_2} = V_{R_3}$$

Current in Parallel Circuits

The relationship of the current in a parallel circuit is as follows:

$$I_t = I_{R_1} + I_{R_2} + I_{R_3}$$

The total current is equal to the sum of the individual branch currents.

The various current entering and leaving a junction are related by *Kirchhoff's current law*.

This law states that "the sum of the currents entering a junction equal the sum of the currents leaving a junction."

Resistance in Parallel Circuits

The total resistance of a parallel circuit is always less than the lowest branch resistance.

By Ohm's law, the total resistance is

$$R_t = \frac{V_t}{I_t} = \frac{V_t}{I_{R_1} + I_{R_2} + I_{R_3}} = \frac{V_t}{\frac{V_t}{R_1} + \frac{V_t}{R_2} + \frac{V_t}{R_3}} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

This formula is often referred to as the reciprocal formula because the reciprocals of the branch resistances are added, and then the reciprocal of this sum is taken to obtain the total (equivalent) resistance.

When only two resistors are in parallel, a simplified formula can be used to solve parallel resistance problems. This simplified formula is derived from the reciprocal formula. It is

$$R_t = \frac{R_1 \times R_2}{R_1 + R_2}$$