

Resistors in Parallel

Resistors in series have the same *current* flowing through them. Resistors in parallel have the same *voltage* across them. In the schematic below, r1 and r2 have identical voltages across them, but have different currents flowing through them. This configuration is also known as a *current divider*.

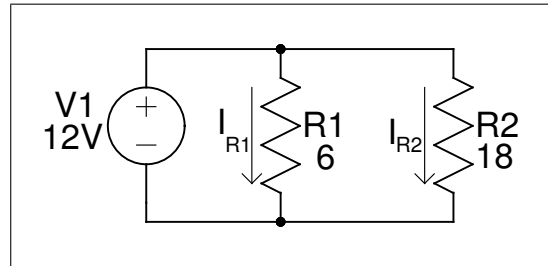


Figure 1: R1 and R2 are in Parallel

Elements in parallel have the same voltage across them and *may* have differing currents. This makes sense intuitively when you think about it. For example, Ohms law tells us that the current through a resistor is inversely proportional to its resistance. Thus the 6 ohm resistor r1 will have three times the current flowing through it that the eighteen ohm resistor r2 would.

In the example above, the currents through R1 and R2 will be:

$$I_{R1} = 12/6 = 2A \quad (\text{three times the current that R2 is passing})$$

$$I_{R2} = 12/18 = 0.67A$$

Both R1 and R2 have the same voltage across them since they are in parallel. When two resistors (or components in general) are in parallel, one end of each component will be connected to the same wire and the two remaining ends will both be connected to another wire. Resistors may be drawn in physically parallel but not be electrically parallel.

Resistors combine in parallel differently than in series. You can reason that each additional parallel current path will make the equivalent resistance less because there are more paths for electrons to flow through. Resistors in parallel combine in the following way:

For any number of resistors in parallel:

$$1/Req = 1/R1 + 1/R2 + 1/R3 + \dots + 1/Rn$$

Thus,

$$Rn = 1/[(1/R1) + (1/R2) + (1/R3) + \dots + (1/Rn)]$$

For any two resistors in parallel an equivalent resistance Req can be expressed as:

$$Req = (R1 * R2)/(R1 + R2)$$

Thus, the circuit above could be redrawn as follows:

$$R_{eq} = (R1 * R2)/(R1 + R2)$$
$$R_{eq} = (6 * 18)/(6 + 18) = 4.5\Omega$$

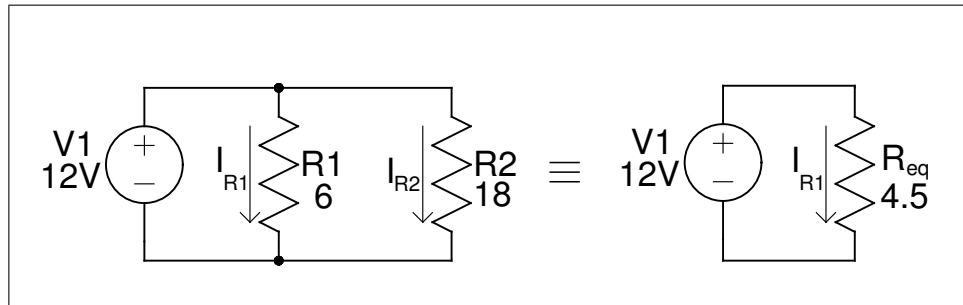


Figure 2: R1 and R2 can be combined to one equivalent resistance

We know this is a correct solution since the total current flowing from the voltage source is identical in each case. For the resistors in parallel, we saw earlier that the total current from the voltage source was:

$$I_{src} = I_{R1} + I_{R2}$$
$$I_{src} = 2 + .67 = 2.67A$$

Ohms law gives us the source current in the equivalent resistor case:

$$I_{src} = 12/4.5 = 2.67A$$

Identical results were obtained for each circuit showing them to be equivalent.

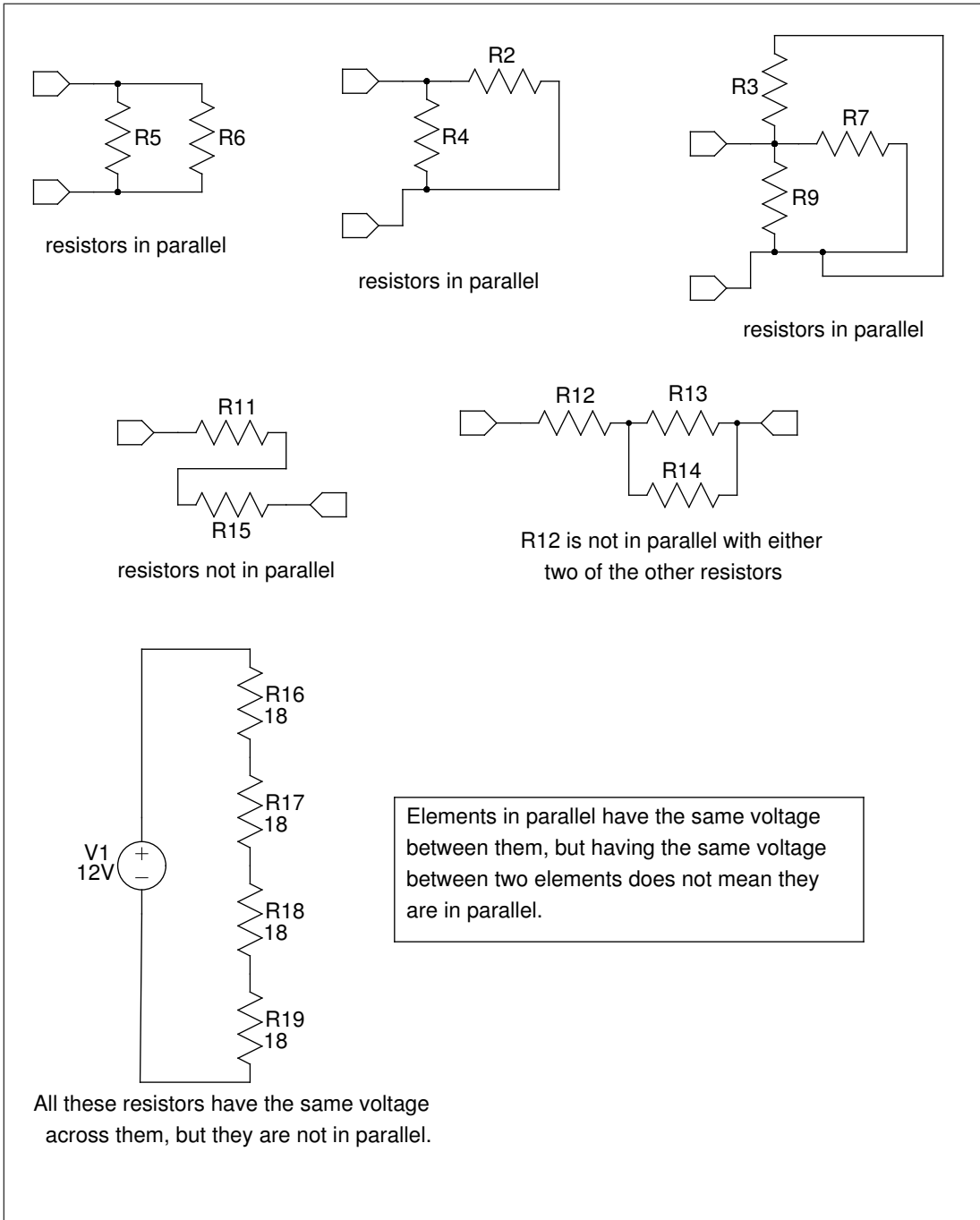


Figure 3: Distinguishing Parallel Elements