Basic Electronics Part 5

by

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When current flows in a resistance, heat is produced. The heat is evidence that power is used in producing current. The power is generated by the source of applied voltage and consumed in the resistance in the form of heat. Power can be expressed in terms of the potential difference or voltage in a circuit and the current in that circuit. The formula for power (P) in terms of voltage (V) and current (I) is

$$Power = (volts)(amperes)$$

$$P = VI$$

Since power is dissipated in the resistance of a circuit, it is convenient to express the power in terms of the resistance R. From Ohm's law, $V = IR$, therefore,

$P = VI = (IR)I = I^2R$.

In deciding what size resistor to use in a circuit, the first requirement is to have the amount of resistance needed. Consider the circuit in fig. 1

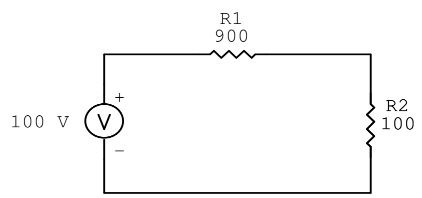

fig. 1

In this case, we are given a resistance in the circuit of 900 ohms (R1) and we want to determine the resistance needed at R2 so the current will be limited to 0.1 A. Using Ohm's law we get

$$R = \frac{V}{I} = \frac{100V}{0.1A} = 1000\Omega .$$

If the combined resistance $R_T = R1 + R2$ and $R1 = 900\Omega$, then the required value of R2 is $1000\Omega - 900\Omega = 100\Omega$ as shown in fig. 1.

The I^2R power dissipated in R2 equals 1 W. This calculation is

$$P = (0.1A)^2(100\Omega) = (0.01)(100) = 1W$$

Normally, if this were a carbon resistor, we would select a 2 W resistor to provide a safety factor of 2 in the power rating. A resistor with a higher wattage rating but the same R could also be used if there is space to physically put it in the circuit. Wire-wound resistors can operate closer to their power rating, assuming adequate ventilation.

Now consider the example in fig. 2

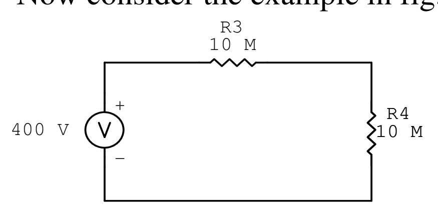

fig. 2

The $10M\Omega$ resistor of R3 is used with the $10M\Omega$ resistor of R4 to provide an IR voltage drop of 200 volts or one-half the source of 400 volts. Since the two resistances are equal, they divide the applied voltage into two equal parts of 200 volts. To calculate this use Ohm's law

$$I = \frac{V}{R} = \frac{400V}{20M\Omega} = 0.00002A$$

or $I = 20\mu A$.

Using Ohm's law again on each resistor we get

$$V_{R3} = (20\mu A)(10M\Omega) = 200V \ .$$

Similarly, $V_{R4} = 200V$.

To calculate the I^2R power dissipated in R4 we proceed as follows:

$$P = (20\mu A)^2(10M\Omega) = 4mW \ .$$

The normal selection would be ¼ watt carbon resistors (250 mW) for R3 and R4. Observe that the power dissipated in this circuit is small even though we have a relatively high applied voltage of 400 volts. The reason is that the very high resistance limits the current to a low value.