

BASICS IN ELECTRICITY

SECTION OBJECTIVES

1. Definitions & Major Concepts
2. Wire Calculations
3. Useful Formulas

1. Definitions

A comparison between electrical energy and water flow will be useful in explaining and understanding electrical concepts, but remember — water and electricity generally should not be mixed.

1. VOLT (Potential) V

The unit of measurement applied to the difference in electrical potential between two points; that is, the potential for electricity to flow.

- Usually referenced from “ground.”
- In water, voltage is roughly equivalent to the difference in elevation from ground to a tank of water elevated above the ground; the electrical potential is similar to water pressure.
- The higher the potential (or elevation), the more force the water is able to exert and the more likely it is to flow.

2. AMP (Current) I

The unit of measurement applied to the flow of electrical current through a conductor.

- The amount of current (electrons) passing through a conductor or passing a point in a wire or other electrical devices such as a light bulb.

3. OHM (Resistance) $R\Omega$

As electrons flow through conductors, they meet opposition due to the collisions between the flowing electrons and the electrons and atoms of the conductor.

- This opposition to current flow, called resistance, is measured in **Ohms**.

4. WATT (Power) P, W or P_w

The unit of power applied to the rate at which energy is used.

- Power is the amount of work that can be accomplished in a specified amount of time.
- Work is simply defined as converting energy from one form to another, e.g., changing electrical energy into light energy.

5. WIRE SIZE (AWG)

Because everything electrical depends on current flow, the conductors that carry the electricity are a critical part of any electrical system. The size of wires is important to allow the proper flow of electrons.

- Resistance is opposition to current flow.
- Wires that are too small in diameter will oppose current flow (this opposition is due to collisions of electrons which do not have enough room to pass).
- These collisions convert electrical energy into heat (if enough of these collisions occur, the wire could overheat to the point of causing insulation melt-down and/or catch fire).
- Wire sizes are measured according to the American Wire Gauge (AWG).

6. VOLTAGE DROP Vd

Voltage drop occurs when power is dissipated across a component of the electrical system.

- In the case of a bulb or other lighting device, voltage is dropped in the production of light and heat.
- Typically, the more current that flows through a system, the higher the voltage drop will be.
- Voltage drop across a wire is undesirable, as it is an indication that power is being wasted and heat is being generated.

7. HORSEPOWER

To determine horsepower required to operate lighting equipment, calculate the total power requirements of all lamps (in watts). Then divide that total by a value of 746 (HP = P / 746).

QTY	LAMP TYPE	INCANDESCENT TOTAL AMPS	LED TOTAL AMPS
11	Clearance/Sidemarkers/Identification	3.63	0.66
1	Licence	0.33	0.06
2	Tail (minor function)	0.96	0.05
2	Rear Clearance (minor function)	0.96	0.05
2	Stop (major function)	4.20	0.61
2	Turn (major function)	4.20	0.61
		14.28	2.04

INCANDESCENT

$$P = V \times I$$

$$P = 12.8v \times 14.28a$$

$$P = 182.784 \text{ watts}$$

$$HP = P \div 746$$

$$HP = 182.784 \div 746$$

$$HP = 0.2450$$

LED

$$P = V \times I$$

$$P = 12.8v \times 2.04a$$

$$P = 26.112 \text{ watts}$$

$$HP = P \div 746$$

$$HP = 26.112 \div 746$$

$$HP = 0.0350$$

2. Wire Size Calculations

The length of wire in a circuit is a major contributing factor to voltage drop. The table below may be used to determine adequate wire gauge sizes for specific lengths of cable when the amperage (current) requirements are known.

- Everything electrical relies upon current flow.
- The conductor that carries the electricity is a critical part of the system.
- Wire size is vital to allow the proper flow of electrons (smaller diameter wire will oppose current flow).
- Constricting the room for electrons to pass within the wire causes collision of electrons, which generates heat inside the wire.

WIRE GAUGE REQUIREMENTS

TOTAL FOOTAGE OF WIRE FROM POWER SOURCE TO THE MOST DISTANT ELECTRIC LAMP

		24v System	12v System	10'	20'	30'	40'	50'	60'	70'	80'	90'	100'
AMPERAGE REQUIRED	2.0	1.0		18	18	18	18	18	18	18	18	18	18
	3.0	1.5		18	18	18	18	18	18	18	18	18	18
	4.0	2.0		18	18	18	18	18	18	18	16	16	16
	6.0	3.0		18	18	18	18	18	16	16	16	14	14
	8.0	4.0		18	18	18	16	16	16	14	14	14	12
	10.0	5.0		18	18	18	16	14	14	14	12	12	12
	12.0	6.0		18	18	16	16	14	14	12	12	12	12
	14.0	7.0		18	18	16	14	14	12	12	12	10	10
	16.0	8.0		18	18	16	14	12	12	12	10	10	10
	20.0	10.0		18	16	14	12	12	12	10	10	10	10
	22.0	11.0		18	16	14	12	12	10	10	10	10	8
	24.0	12.0		18	16	14	12	12	10	10	10	8	8
	30.0	15.0		18	16	12	12	10	10	10	8	8	8
	36.0	18.0		16	14	12	10	10	8	8	8	8	8
	40.0	20.0		16	14	12	10	10	8	8	8	8	6

* Values depict wire gauge

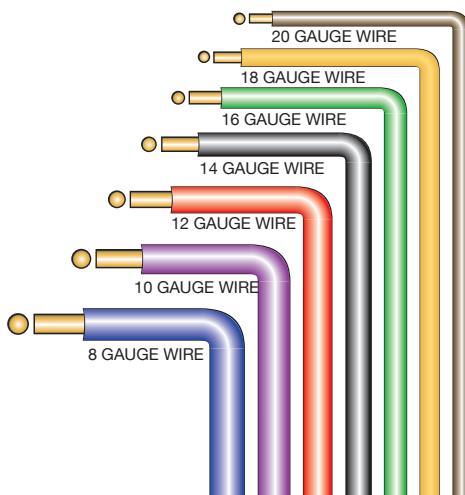
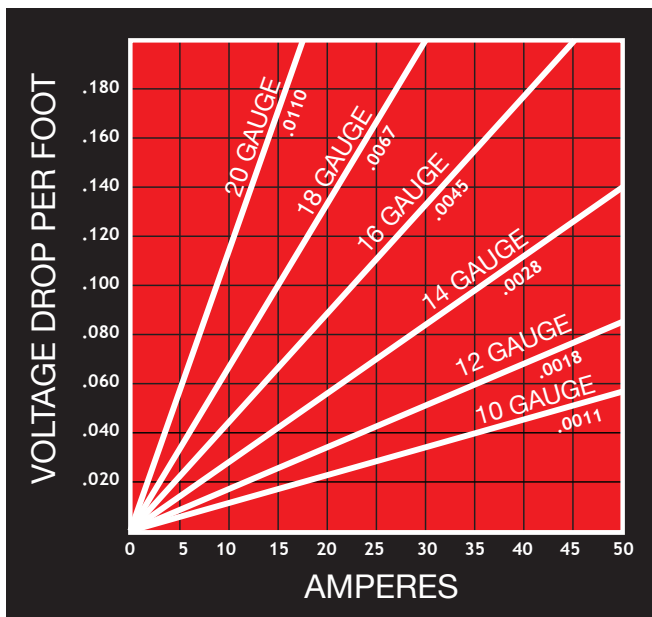
Wire Size Calculations continued on next page ->

Example: A lamp is 38' from the power source and required 10 amperes. This figure, rounded upwards to the nearest column heading given in the table is 40'. The wire gauge in the 40' column corresponding to 10 amperes is No. 12.*

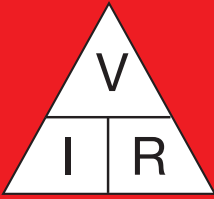
*Recommended minimum wire gauge size for stop light and ground circuits.

	Stop (red)	Ground (white)
Single trailer up to 50' length	12 ga.	10 ga.
Double trailer 2-28' lengths	12 ga.	10 ga.
Doubles trailer 2-40' lengths	10 ga.	8 ga.
Triples trailer 3-28' lengths	10ga.	8 ga.

*Compiled from SAE, TMC & Other sources.



3. Useful Formulas



V - Potential in Volts (E)*
 I - Current in Amps
 R - Resistance in Ohms

* E is the symbol for Electromotive Force in Volts, as defined in Ohms Law.

$$V = I \times R$$

Voltage (volts) = Current (amps) x Resistance (ohms)

$$I = \frac{V}{R}$$

Current (amps) = Voltage (volts) ÷ Resistance (ohms)

$$R = \frac{V}{I}$$

Resistance (ohms) = Voltage (volts) ÷ Current (amps)

Frequently stated as $E = I \times R$

Power can be represented as P, W, or Pw.

a) $Pw = V \times I$

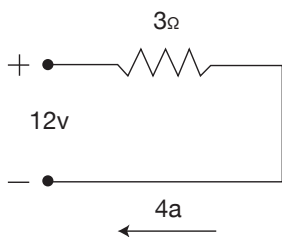
Power (watts) = Voltage (volts) x Current (amps)

b) $Pw = I^2 \times R$

Power (watts) = Current (amps) x Current (amps) x Resistance (ohms)

c) $Pw = \frac{V^2}{R}$

Power (watts) = Voltage (volts) x Voltage (volts) ÷ Resistance (ohms)



a) $P_w = V \times I$

$$P_w = 12 \times 4$$

$$P_w = 48w$$

b) $P_w = I^2 \times R$

$$P_w = 4 \times 4 \times 3$$

$$P_w = 48w$$

c) $P_w = \frac{V^2}{R}$

$$P_w = 12 \times 12 \div 3$$

$$P_w = 48w$$