



Lesson 3 Lecture 2 - Alternating & Direct Current

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Lesson Goal: To understand the difference between Alternating Current and Direct Current and how they are generally used.

1. **What is Current**
 - a. Current is a flow of electric charge
2. **What does the term Direct Mean?**
 - a. To follow a straight course
3. **What does the term Alternate Mean?**
 - a. To change from one to another repeatedly
4. **How do these terms apply to Electricity?**
 - a. Alternating current cycles back and forth over time
 - b. Direct current is constant
 - c. It is usually discussed in terms of the supply voltage used to generate it

Direct Current (DC)

5. **What is Direct Current (heretofore known as DC)?**
 - a. Let's refer back to Ohm's Law
 - i. If V and R are constant – what happens to I?
 - ii. $V=I*R$
 - iii. If V=24 Volts of potential difference and R=24 Ohms of resistance then what is the resulting current?
6. **Where is Direct Current Used?**
 - a. Everywhere!
 - b. Most electronic items run on DC Voltage/Current
 - c. Most Controls, inputs and outputs in Automation are DC in nature
 - d. What comes out of the wall at your home is actually AC – but is typically converted to DC in order to use it for various work

7. What types of devices use DC?

- a. Anything that uses batteries or a power chord that plugs into your wall and is a big box that goes to a small push in connector
- b. Examples: Cell Phone, Computer, Blue Tooth Speaker, LED Desk Lamp, Power Tools, Drones, Flashlights, Laser Pointers, PLC, Proximity Sensor, Photoelectric Sensor, Ultrasonic Sensor, Capacitive Proximity Sensor, Solid State Relays, etc. etc.
- c. Unless you are using a battery, DC must be converted from AC in order to do the work in these devices. How is that done? What is AC anyway? Well, glad you asked...

Alternating Current (AC)

8. What is Alternating Current (heretofore known as AC)?

- a. Let's refer back to Ohm's Law...AGAIN!!! (Remember what I said about this law in the last lesson?!?!?)
 - i. If V or R vary over time – what happens to I?
 - ii. $V=I \cdot R$
 - iii. If $V=24$ Volts of potential difference, but it varies from 24Volts to 0 and actually changes polarity so that it is the opposite of where it started so it is actually -24 Volts and then back to 0 and so one say each second and $R=24$ Ohms of resistance then what is the resulting current?

9. Where is Alternating Current Used?

- b. Everywhere!
- c. AC is the form electricity is generated in at the Power plant
- d. Power travels onto the National Electrical Grid to various places over the electrical lines hung throughout our country (and underground)
- e. What comes out of the wall at your home is actually AC – but is typically converted to DC in order to use it for various work
- f. The reason Power is provided in AC form is due mainly:
 - i. to a thing called a transformer which can be used in AC circuits to step up or step down AC voltage levels. It is harder to do this (and more costly) with DC

ii. Resistance builds up in a wire over it's length and as such there is a loss of power due to the current dropping due to a higher resistance

1. At 10' resistance is 10ohms
2. At 100' it's 100 ohms
3. This affects DC signals at a greater level than AC due to AC signals looking at impedance rather than just resistance
4. Impedance is the square root of the sum of the squares of the resistance and reactance of the circuit and usually expressed in ohms.

g. AC Signals are what travels through the air from a Radio, TV, Satellite, Bluetooth, or Wireless transmission

- i. Most also call this an Analog signal – versus a DC signal being called digital
- ii. Digital signals are embedded into AC (analog) signals for transmission and then extracted after received

10. Some devices use AC for power and do not have it converted to DC – what are some examples?

- h. Many applications using an electric motor, incandescent light bulb, some electric appliances
- i. Examples: Pump, Blower Motor in your AC/Furnace, Room Fan, Non LED lights, Popcorn Power, Hair Dryer etc.
- j. Motors: come in DC and AC 0 many run on AC due to the available power

11. How does AC become DC?

- a. Typically AC from the grid is stepped down through a transformer, then converted in a Power Supply circuit where a DC Voltage is then present
- b. What is a Transformer?
 - i. Two coils of wire made up of a primary and a secondary winding which allows AC Voltage to be transferred over a gap and stepped up or down.

12. Why do devices use DC instead of AC?

- a. There are several reasons for this – but the main one is due to needing most devices today to be Digital in nature instead of Analog
- b. A Digital device is something that works on a threshold basis
 - i. A threshold might be a voltage or current level – but it is always consistent and in the digital world is based on the type of PN junction you have your electronics based on.
 - ii. This for PN junctions can be from .3V to .7 volts typically
 - iii. In the Digital world – a signal lower than .7 volts is a 0 (ZERO or OFF State) and higher than .7 Volts is a 1 (ONE or On state)
- c. Analog devices have a varying nature – not necessarily AC – but is able to vary over time.
- d. Much of the work electrical items do is converting AC and DC back and forth.

13. How do we measure AC?

- a. Remember DC is measured in Volts, Amperes. And Ohms
- b. AC is measured in the same terms, however there are two new terms we must understand
- c. Cycles per Second – measured in Hertz
 - i. Tells us how fast an AC signal is changing
 - ii. 1Hz=1 cycle per second
- d. Impedance – measure of resistance in an AC circuit. Total resistance in an AC circuit is a measure of any physical resistance and that of impedance which varies with the voltage and frequency being applied to a circuit

14. Summary

- a. Both AC and DC current functions with regard to ohm's law
- b. AC is the preferred method in the US of making Electrical Power available
- c. DC is the preferred method for most electronic devices
- d. The terms Analog (AC) and Digital (DC) are part of this discussion
- e. Electrical Current can be very dangerous as it can cause immense harm yet it is invisible to the eye

