ELECTRICITY

- Electrons in motion traveling through a conductor

ALTERNATING CURRENT

- Alternating current (AC) is the flow of electricity back and forth in a conductor at regular intervals. The rate of flow reversal is called “frequency.” Nearly all AC power systems in this country operate at a frequency of 60 cycles per second. This means that the electricity flows in one direction for 1/120 of a second and then in the other direction for 1/120 of a second. The current makes one complete cycle in 1/60 of a second or 60 complete cycles in one second.
IV. Alternating Current

- cyclic vibration of charge -

How do AC plants so efficiently transmit power across hundreds of miles without appreciable loss?

What are:
- Cycles
- Transformers
- Ungrounded Conductors (Hot)
- Grounded Conductors (Neutral)
- Grounding Conductors (Green or Bare)

- 60Hz in the U.S.
- 50Hz in Europe

60Hz devices are not compatible with 50Hz counterparts, and vice versa.

Inverters are sold that operate at one or the other, not both.

Cycles

Hertz is the unit of periodic frequency per second.

Alternating Current changes direction many times per second:
- 60Hz in the U.S.
- 50Hz in Europe

60Hz devices are not compatible with 50Hz counterparts, and vice versa.

Inverters are sold that operate at one or the other, not both.

The sine wave is commonly used to illustrate alternating current. The graph below shows the sine wave for a single-phase (1ø) AC current. The complete AC cycle is divided into two half cycles—the first is given a positive value and the second a negative value. The first half cycle (+) begins at zero and rises to a peak before returning to zero, at which point the second half cycle (-) peaks and returns to zero again.
The disadvantage of single-phase AC is that electrical power is cut off each time the current reaches "0." This problem can be avoided with a three-phase (3ø) AC system that provides overlapping AC cycles. The power supplied to a motor or other device is never cut off because when one phase reaches "0," the other two phases are either positive or negative.

<table>
<thead>
<tr>
<th>0°</th>
<th>90°</th>
<th>180°</th>
<th>210°</th>
<th>360°</th>
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Three-Phase AC

Three Phase Power

In 120/208 V systems:
- Line 1 is Black
- Line 2 is Red
- Line 3 is Blue

In 277/480 V systems:
- Line 1 is Brown
- Line 2 is Orange
- Line 3 is Yellow

A Three Phase System has three current carrying conductors, phased 120° apart.

LEARNING OBJECTIVES

- Define the DC types of electrical current
DIRECT CURRENT

Direct current (DC) is the constant flow of electricity through a conductor in one direction. A dry-cell battery connected to a light bulb is an example of a simple dc circuit.

ELECTRICAL ENERGY SOURCES

- Chemical Storage
  - Batteries
- Light Sources
  - PV
- Electromagnetic Induction
  - Wind & Micro-hydro Turbines
  - Utility Grid
  - Generators

ELECTRICAL TERMINOLOGY

Watt (W) = Power
- Unit rate of electrical energy
- Amps x Volts = Watts
- ____ A x 12V = 120W
- ____ A x 120V = 120W

Kilowatt (kW)
- 1000 watts
- 10,000W = ____ kW
- 2,500W = ____ kW
WATTS CALCULATION

What size (W) is this array?

100W 100W 100W 100W 100W 100W
______ W
______ kW

WATT'S LAW

The basic form of Watt's Law states that electrical power (P) in a simple dc circuit is the product of current and voltage.

\[ P = I \times E \]

\[ I = \frac{P}{E} \]

\[ E = \frac{P}{I} \]

Where:
- \( P \) = power in watts
- \( I \) = current (intensity) in amperes
- \( E \) = voltage (electromotive force) in volts

Watts: Rate of Power

Watts: Unit of electrical power, the rate at which energy is being used or generated.

In PV, the amount of power a module or an array can generate.
Watts is the Product of Volts and Amps

Volts x Amps = Watts

12 volts x 5 amps = 60 watts

**DC Applications**

- Battery power is DC.
- PVs produce DC.
- Most DC applications, nearly all electronics included, convert grid supplied AC through a RECTIFIER.
- Thin film deposition.
- DC is transformed to AC through a Motor-Generator set or an INVERTER.