

Difference between True Power and Volt-Amp (VA)

A common misconception is that the power used by a household load or appliance can be calculated by multiplying the voltage and current to that load. **This is false!** This method of power measurement would only apply to such loads as:

- Incandescent light bulbs
- Any heating device without a fan such as toaster, baseboard electric heater, kettle, etc.

These are called “**Resistive Loads**”.

The method of multiplying Volts x Amps to calculate power **CANNOT** be used for any load using an electric motor, a transformer, a ballast or a switching power supply such as modern electronics do.

These types of loads include:

- Refrigerators, Freezers
- Air conditioners (all types)
- Fluorescent lights including CF lights
- TV, computer, stereo, any wall-wart
- Microwave Oven
- Washer, Dryer
- Vacuum cleaner
- Fans
- Power tools: grinder, electric saw, compressor, etc.
- Humidifier, dehumidifier
- Garage door opener, pool pump, electric lawn mower, etc

These are called “**Inductive Loads**” (or switching power supply loads for modern electronics)

The inductive loads will return a portion of the energy used back to the source (power company).

Power Measurement (*brief overview*)

“**Power**”, which is measured in watt or kilowatt, is the electrical equivalent of “**Horsepower**” when referring to mechanical energy or “**BTU**” (British Thermal Unit) for energy in the form of heat.

Just as the amount of horsepower delivered by an engine is a function of torque and RPM, so is the electrical power a function of voltage and current.

When buying electricity, the consumer is charged for energy used. Electrical energy is the amount of power used over a period of time and is stated as:

Watt-Hour (**Wh**) Or Kilowatt-Hour (**KWh**)

(1,000 **Wh** = 1 **K Wh**)

A load which uses 1,000 Watt will consume 1,000 Watt-Hour after being operated for one hour. Since using the units of “Watt” produces large values of energy, the electric company uses the “Kilo-Watt” unit of measure. This is done for the same reasons that highway speed limits are stated as “90 KM/H”, instead of “90,000 M/H”.

The basis for measuring electrical energy consumption is the power measurement. Once “true” power is measured, it is then a matter of continuously metering the power over time to determine the kilowatt-hour value.

There is often a misconception that measuring AC power is the same as measuring DC power. This is not so. The next two paragraphs will illustrate how power is measured and calculated for:

1. DC Circuits
2. AC Circuits

1. Power In DC Circuits:

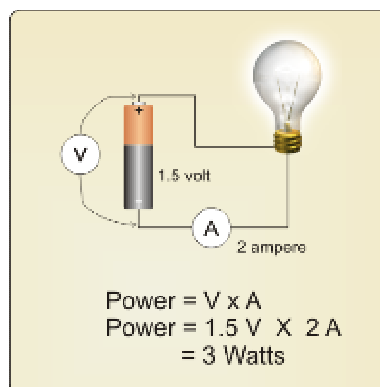


Figure 1: A Simple DC Circuit

The power in a DC circuit is easily determined by multiplying the voltage (V) by the current (A). This is about as simple as it gets.

2. Power in AC Circuits:

Figure 2 illustrates a circuit of an AC fan powered by 120V AC. If you compare the examples of figure 1 and figure 2, you will notice a difference in the way the power is calculated.

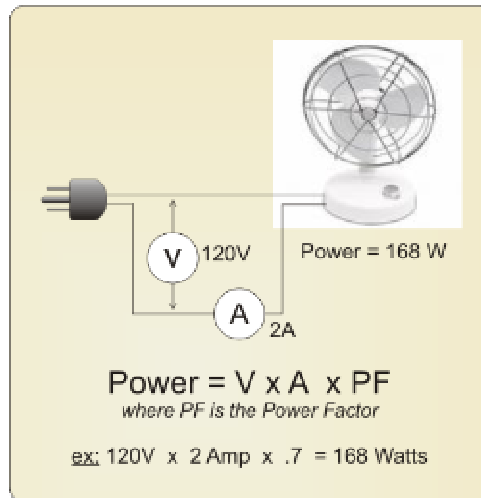


Figure 2: A typical AC Circuit

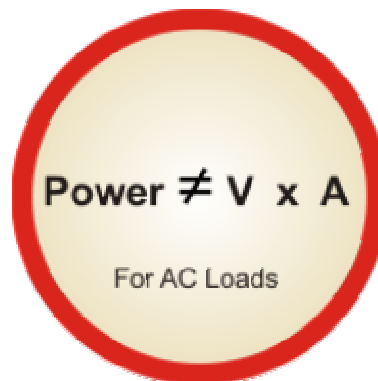
When it comes to measuring power of AC circuits, the power formula for DC circuits no longer apply!

As you can see in the example of figure 2, multiplying the voltage by the current would give you a value of “240”. This is not the power consumed by the fan. This value is called “apparent power” and the units are VA (volt-amps) or KVA (kilo-volt-amps). In this example, the apparent power is 240 VA.

In this example the apparent power and true power are totally different:

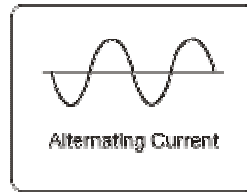
Apparent Power = 240 Volt-Ampere

True Power = 168 Watts (*The Electric Company charges for True Power!*)



Why can't we use the “V x A” formula in AC circuits?

As you probably know, **AC** stands for “Alternating Current”. This means that the current is continuously varying in magnitude and polarity, as shown in the diagram below.



When powering certain AC loads, the dynamic nature of alternating current causes a portion of the energy delivered to the load to be momentarily stored then returned back to the source which is the power company. This energy storage/release would typically occur 120 times per second for a 60Hz service.

As a result of this, the increase of electrical current makes it appear that more power is being consumed than actually is.

In AC circuits, the product of multiplying the current by the voltage is called “apparent power”, because it appears that this is the energy consumed when in reality it may be less.

The electrical unit for “Apparent Power” is **VA** (Volt Amps) and not Watt. This is simply a multiplication of the “**V x A**”.

Since the power company only charges for power consumed (True Power), “apparent power” is not practical for determining energy consumption.

To determine energy consumption, it is required to measure the portion of energy consumed by the load, disregarding the amount of energy stored and returned to the source. The ratio of the “True Power” which is the power actually consumed, to “Apparent Power” is called the “Power Factor”.

$$\text{Power Factor(PF)} = \frac{\text{True Power (Watt)}}{\text{Apparent Power (VA)}}$$

OR

$$\text{Power (Watt)} = \text{Apparent Power (VA)} \times \text{PF}$$

To properly measure AC power and energy requires the Voltage and Current to be sampled at the same time, to determine how much energy is received and how much is returned. This is the method used by the ECM-1220 for its energy measurement.

Other valid terms for “True Power”:

- Active Power
- Real Power
- True RMS Power