IS-9-Alternating Current - Anatomy of a Sine Wave

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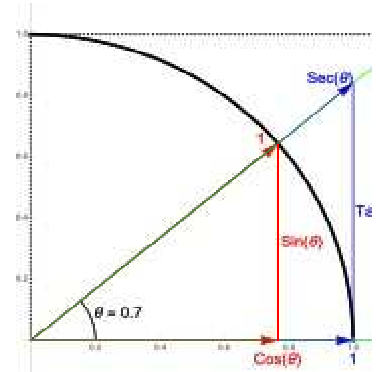
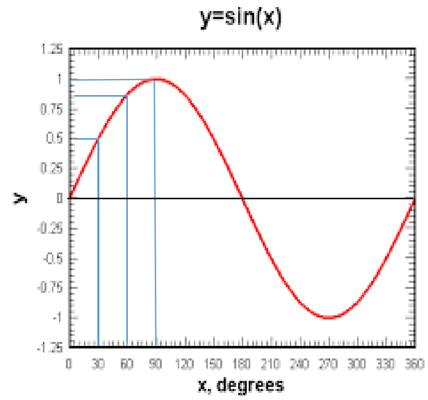
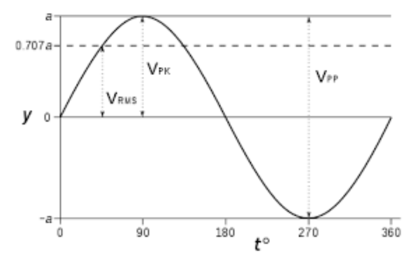


Alternating current behaves in a similar manner to direct current except it changes direction in regular cycles. The voltage and current values rise from zero to a peak, back through zero to a peak of opposite polarity and back to zero. This would be one complete cycle. But the amplitude changes are not a linear function. They rise and fall according to a trigonometric function. This is the "sine" of the phase angle "Theta" (Θ). The red line opposite of the angle in figure 1 is the sine of that angle. It represents the amplitude of the sine wave. At 45 degrees the amplitude is about 71% (.707) of the peak value. At 90 degrees, the slanted line is straight up, the "sine" is 100% (1).



A sine wave is divided into 360 points called degrees. Degrees also represent the phase departure from zero. These are the bottom numbers in Fig. 2. The left side numbers represent (y), the amplitude of the wave. The amplitude (y) of the wave is the sine of the phase angle Theta. Its abbreviated form is Sin Θ =Y or Sin(x) =y. In other words, the amplitude at 30 degrees is .50 or 50% of peak amplitude. Amplitude of 60 degrees is .866 or 87% of peak. At 90 degrees the amplitude is 1 or 100%.

The time (t) to complete one cycle is its "period". 1/t = frequency and 1/f = t. Examples: 1/.000001 Sec = 1/1MHz and 1/1MH z = .000001sec



A value often needed is the "RMS" value of the voltage and current. RMS stands for "Root Mean Square". This is the square root of the sum of the squares of different values within the sine wave envelope. Luckily we don't have to solve for this. For a sine wave this is 70.7% (.707) of the peak value. This is the value that equates to that value of direct current. That is, the amount of work that can be performed such as heating, motors, etc. 120V AC does the same amount of work as 120V DC.

This is not the end of the story. When we speak of household current we say "120 volts AC". This actually refers to the RMS value. The peak value is 1.414 times the RMS value = 169.68 volts! The peak to peak (P-P) value is twice that, almost 340 volts! You can see where this would be important in designing a power supply or purchasing parts with the proper voltage rating. Example: An input of 120 volts RMS to a half-wave rectifier in a power supply yields 169 Volts DC at its output. A filter capacitor rated at 150Vdc, based on "120VAC", would not be the right choice.

Another aspect, which we'll talk more about later is "true power" versus "apparent power". True power consumed by a load is when the current and voltage are in phase. This would be a resistive load such as an electric heater. Electric motors, however, are inductive whereas the current phase lags the voltage phase. The current and voltage demand are not at the same time. The apparent power might be 120VAC at 10 Amps = 1200 Watts. But, if the current lags the voltage, say by 45 degrees, things change. The formula for true power is E I Cos Θ. At 45 degrees the Cosine is .707. So, 120VAC x 10 A x .707 = 848 W

Alternating current can do things which direct current cannot. As you learned earlier, current flowing through a wire creates a magnetic field around it. A magnetic field produced by AC rises and falls in strength. In effect the field is moving. Another wire within that field will have a resultant current flow. This is called "electromagnetic induction". This is how alternators, generators and transformers work.