

# Chapter 1

## Electrical Fundamentals

Every relay technician should thoroughly understand the basics of electricity and power systems and this first chapter is dedicated to these topics.

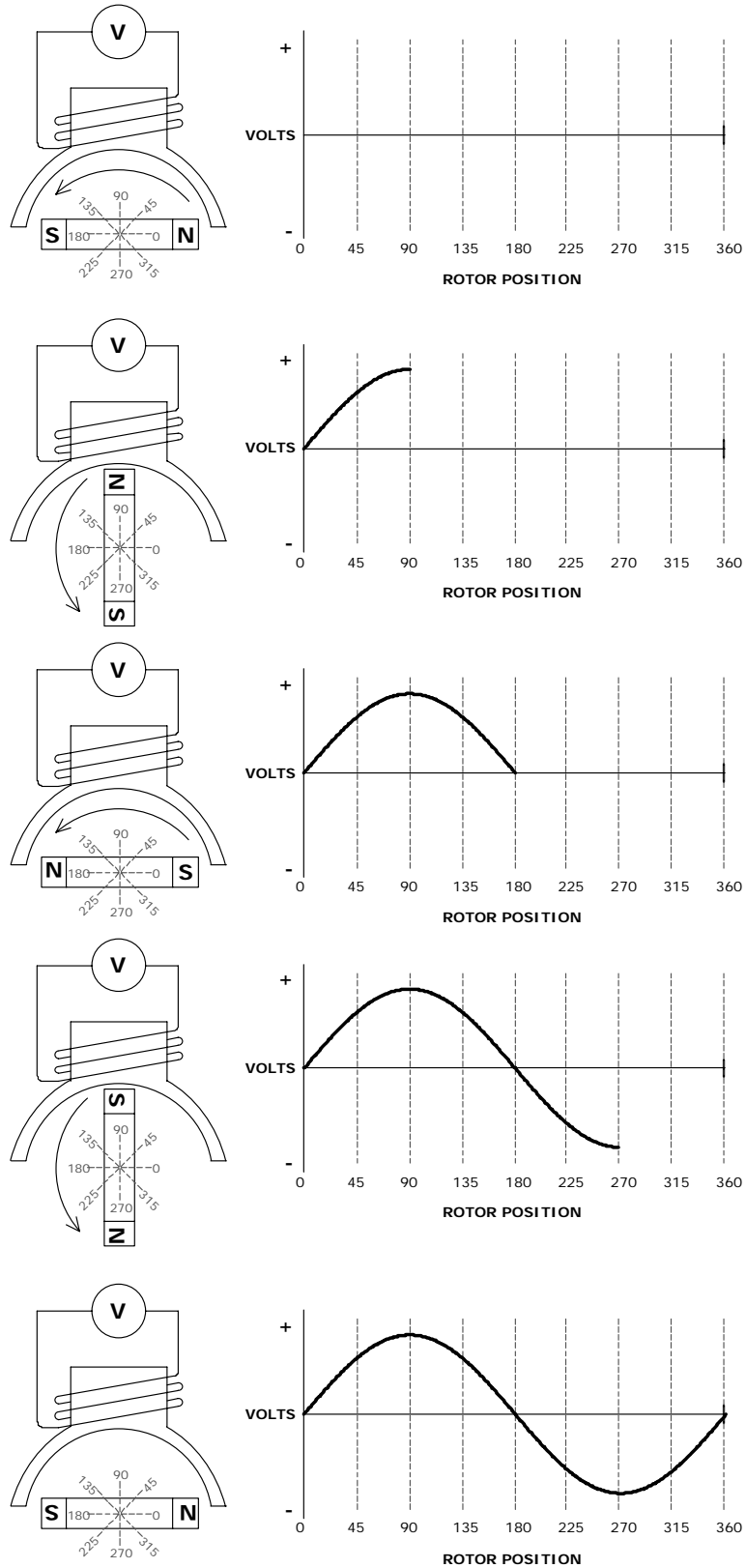
### 1. The Three-Phase Electrical System

Many people have difficulty understanding or visualizing a three-phase electrical system. While understanding the relationships between phases is not necessary for simple current / voltage / frequency relay operation, it is imperative when testing more complex protective elements. The following explanations take some technical shortcuts and have been simplified to help (hopefully) you to better understand three-phase electricity.

#### A) Generation

Almost all electrical systems are supplied by generators of one sort or another. Although generators can operate using gas, diesel, steam, water, wind, etc.; actual generator construction is basically the same despite the input fuel. A generator rotor is inserted within the centre of stator poles installed on the outside edge of the circular generator. The rotor is a large electromagnet that is rotated within the stator poles via a prime mover which can be turned by any of the fuels described previously. The generator voltage is determined by the number of coils wrapped around each iron core in the stator poles and the strength of the rotor's magnetic field. As the rotor rotates within the stator poles, the magnetic interaction between the rotor and stator creates a voltage. The rotor/stator magnetic interaction, and subsequent voltage, varies as the rotor's alignment to the poles change. The following diagram shows a simple generator sine wave. Notice how the horizontal scale of the sine wave graph corresponds to the rotor position inside the stator. When the north pole of the magnet interacts with the pole, the induced voltage is positive and the south pole creates negative voltage. In our example a cycle is equivalent to one full rotation of the rotor.

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**Figure 1- 1: Simple Single Phase Generator**