



## PLTW Engineering

# 10-12/Basic Voltage Transformers

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10-12/DE

Lesson: 5/4/2020

**Objective/Learning Target: Students will be able to explain the uses of transformers in electrical circuits.**



## What is a transformer?

Transformers are electrical devices consisting of two or more coils of wire used to transfer electrical energy with a rapidly changing magnetic field.



## What are transformers used for?

One of the main reasons that we use alternating AC voltages and currents in our homes is that AC supplies can be easily generated at a convenient voltage, then transformed into much higher voltages and then distributed around the country using a national grid of pylons and cables over very long distances.



## What are transformers used for?

The reason for transforming the voltage to a much higher level is that higher distribution voltages implies lower currents for the same power, and therefore lower current losses along the networked grid of cables.

These higher AC transmission voltages and currents can then be reduced to a much lower, safer and usable voltage level where it can be used to supply electrical equipment in our homes and workplaces, and all this is possible thanks to the basic voltage transformer.



## How does a voltage transformer work?

A voltage transformer can be thought of as an electrical component rather than an electronic component.

A transformer is a very simple static electro-magnetic passive electrical device that works on the principle of Faraday's law of induction by converting electrical energy from one value to another.



## How does a voltage transformer work?

The transformer does this by linking together two or more electrical circuits using a common oscillating magnetic circuit which is produced by the transformer itself.



## Mutual Induction and its effects on transformers

Mutual induction is the process by which a coil of wire magnetically induces a voltage into another coil located in close proximity to it.

Transformers get their name from the fact that they “transform” one voltage or current level into another.





## Transformer capabilities

Transformers are capable of either increasing or decreasing the voltage and current levels of their supply, without modifying its frequency, or the amount of electrical power being transferred from one winding to another via the magnetic circuit.



## Common types of transformers

A single phase voltage transformer is the most common type of transformer and basically consists of two electrical coils of wire, one called the primary winding and another called the secondary winding.

In a single-phase voltage transformer, the primary is usually the side with the higher voltage.



## Transformers and ratios

Transformers are all about ratios.

The ratio of the primary to the secondary, the ratio of the input to the output, and the turns ratio of any given transformer will be the same as its voltage ratio.

In other words for a transformer: turns ratio = voltage ratio.



## Transformer examples #1

A voltage transformer has 1500 turns of wire on its primary coil and 500 turns of wire for its secondary coil.

What is the turns ratio (TR) of the transformer?

$$\text{T.R.} = \frac{N_P}{N_S} = \frac{\text{\#Pri. Coils}}{\text{\#Sec. Coils}} = \frac{1500}{500} = \frac{3}{1} = 3:1$$



## Transformer examples #2

If 240 volts is applied to the primary winding of the same transformer above, what will be the resulting secondary no load voltage.

$$\text{T.R.} = 3:1 \text{ or } \frac{3}{1} = \frac{V_P}{V_S} = \frac{\# \text{Pri. Volts}}{\# \text{Sec. Volts}} = \frac{240}{V_S}$$

$$\text{Sec. Volts, } V_S = \frac{V_P}{3} = \frac{240}{3} = 80 \text{ volts}$$



## Quiz yourself

1. List 2 reasons for the use of transformers.
2. Is a transformer considered an electromagnetic device?
3. At the most basic form, explain what a transformer does.
4. When a voltage is transformed and changed, does the frequency of the voltage also change?
5. In a single phase transformer, which side has the higher voltage?
6. In a transformer, the ratio of turns is equal to which other value?



## Helpful links

[Youtube video with examples of transformer applications](#)

[Explanations of transformer properties](#)