Difference Between Voltage Converter and Transformer

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Key Difference - Voltage Converter vs Transformer

In practice, voltage is supplied from many difference sources, often by the mains power. Those voltage sources, either AC or DC, have a specific or a standard value of voltage (for example, 230V in AC mains and 12V DC in a car battery). However, the electrical and electronic devices do not really work in these specific voltages; they are made to work on that voltage by a voltage conversion method in the power supply. Voltage converters and transformers are two types of methods that perform this voltage conversion. The key difference between voltage converter and transformer is that **transformer is only able to convert AC voltages** whereas **voltage converters are made to convert between both types of voltages.**

What is a Transformer?

A transformer transforms a time varying voltage, typically a sinusoidal AC voltage. It works on the principles of electromagnetic induction.

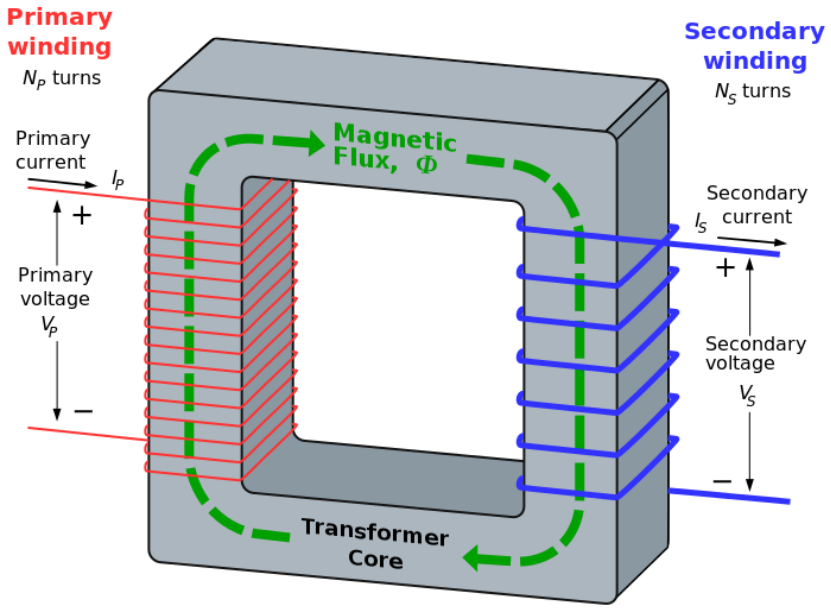

Figure 01: Transformer

As depicted in the above figure, two conductive (usually copper) coils, primary and secondary, are wound around a common ferromagnetic core. As per the Faraday's law of induction, the varying voltage on the primary coil produces a time-varying current that runs around the core. This produces a time-varying magnetic field and the magnetic flux is transferred through to core to the secondary coil. The time varying flux creates a time-varying current in the secondary coil and consequently, a time-varying voltage on the secondary coil.

In an ideal situation where no power loss occurs, the power input to the primary side is equal to the output power at the secondary. Thus,

$$I_pV_p = I_sV_s$$

Also,

$$I_p/I_s = N_s/N_p$$

This makes the voltage conversion ratio equal to the ratio of the number of turns.

$$V_sV_p = N_s/N_p$$

For example, a 230V/12V transformer has the turn ratio of 230/12 primary to secondary.

In power transmission, generated voltage at power plant should be stepped up to make the transmission current low, thereby making power loss low. At substations and distribution stations, voltage is stepped down to the distribution level. On an end application like a LED bulb, the mains AC voltage should be converted to about 12-5V DC. **Step-up transformers** and **step-down transformers** are used to raise and lower the primary side voltage into the secondary, respectively.

What is a Voltage Converter?

Voltage conversion could be performed in many forms such as AC to DC, DC to AC, AC to AC and DC to DC. However, DC to AC converters are usually called as inverters. Nevertheless, all these converters and inverters are not single-component units like transformers, but are electronic circuits. These are used as different power supply units.

AC to DC Converters

These are the most common type of voltage converters. These are used in power supply units of many appliances to convert AC mains voltage to DC voltage for the electronic circuitry.

DC to AC Converter or Inverter

These are mostly used in backup power generation from battery banks and solar photovoltaic systems. The DC voltage of the PV panels or batteries is inverted to AC voltage to supply the mains power system of the house or a commercial building.

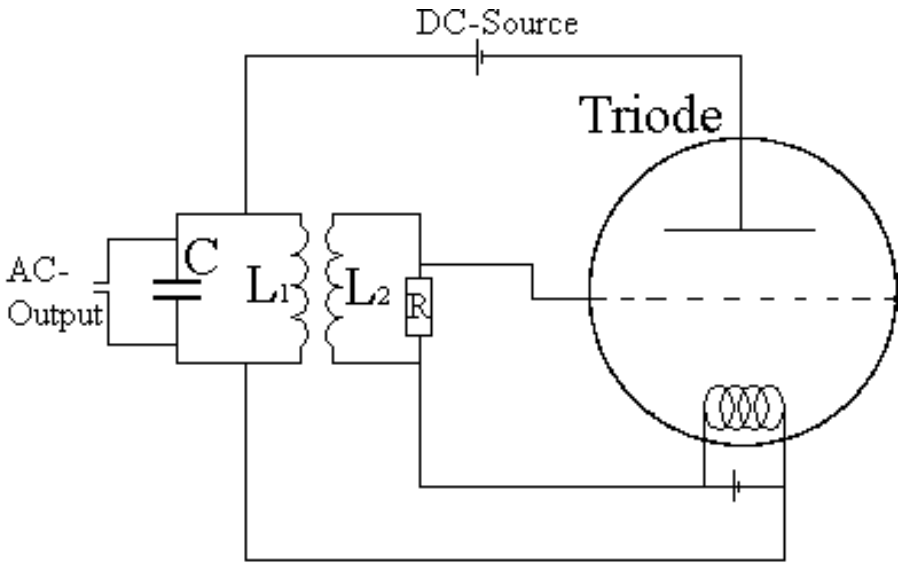

Figure 02: Simple DC to AC converter

AC to AC Converter

This type of voltage converter is used as travel adapters; they are also used in power supply units of appliances made for multi-countries. Since some countries like USA and Japan use 100-120 V in the national grid and some like Sri Lanka use 220-240V, manufacturers of electronic appliances like TVs, washing machines, etc. use this type of voltage converters to change the voltage of the mains to a matching AC voltage before converting into DC in the system. Travelers going from one country to another might need travel adapters for difference countries to make their laptops and mobile chargers adapt to the county's grid voltage.

DC to DC Converter

This type of voltage converters are used in vehicle power adapters to run mobile chargers and other electronic systems on the vehicle battery. Since the battery usually produces 12V DC, the devices may have to change the voltage from 5V to 24V DC depending on the requirement.

The topology used in these converters and inverters may be different from one to another. There, they may use transformers as well to convert high voltage to a lower one. For example, in a linear DC power supply, a transformer is used at the input to lower the AC mains to a desired level. But, there are transformer-less applications as well. In transformer-less topology, DC voltage (either from input or converted from AC) is switched on and off to make a high-frequency pulsed –DC signal. The on-off time ratio define the output DC voltage level. This can be considered as a step-down transformation. In addition, buck converters, boost converts and buck-boost converters are employed in converting this pulsating DC voltage into a desired higher or lower voltage. These type of converters are solely electronic circuits made up of transistors, inductors, and capacitors.

However, designs involved in transformer-less circuits and switched mode power supplies which use comparatively smaller transformers are cheaper to produce. Moreover, their efficiency is higher and the size and weight are less.

What is the difference between Voltage Converter and Transformer?

Voltage Converter and Transformer	
There are different types of voltage converters to perform conversions between both DC and AC voltages.	Transformers are only used to convert alternating voltages; they cannot operate in direct current.
Components	
Voltage converters are electronic circuits, sometimes equipped with transformers as well.	Transformers are made up of copper coils, terminals, and ferrite cores; it is a stand-alone device.
Working Principle	
Most voltage converters work on electronic principles and semiconductor switching.	The basic principle of the transformer operation is electromagnetism.
Efficiency	
Voltage converters have comparatively higher efficiency due to low heat	Transformers are less efficient since they face several power losses including high heat

generation during semiconductor switching.	generation due to copper.
Applications	
Voltage converters are mostly used in portable devices such as power adapters, travel adapters, etc. since they are lighter and smaller.	Transformers are used in many applications, even in voltage converters. However, if higher voltages are to be converted, large transformers has to be used.

Summary - Voltage Converter vs Transformer

Transformers and voltage converters are two types of power converter devices. While a transformer is a stand-alone single device, voltage converters are electronic circuits made up of semiconductors, inductors, capacitors, and sometimes even transformers as well. Voltage converters can be used with DC or AC input to convert them either to AC or DC. But transformers can only have an input of AC voltages. This is the main difference between voltage converter and transformer.

Reference:

1."Transformer." Wikipedia. Wikimedia Foundation, 07 June 2017. Web. Available here. 13 June 2017.
2."Voltage converter." Wikipedia. Wikimedia Foundation, 23 Apr. 2017. Web. Available here. 13 June 2017.

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