

# The Structure and Function of a Transformer

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A transformer is a commonly used electrical device with electromagnetic principles. Transformers' introduction in the electrical world solved the problem of power channeling and distribution. The fact that wires transmit power ensures there is minimal loss of energy through heat and other forms of power loss.

With the knowledge of  $P=VI$ , transformers are used to accumulate the amount of voltage; the actions reduce the current being transmitted, consequently reducing power loss. Transformers are used in a wide assortment of electrical products. The function of the transformers in the process is to step down the voltage being transmitted. The above ensures the energy the end user receives is suitable for the electronic device. Most transformers comprise three major parts: the primary coiling, the secondary winding, and the core. Furthermore, the functionality of a transformer is based on two fundamental processes: [magnetism and electromagnetic induction](#). Also, the voltage in the input is dependent on the magnitude of the input voltage as well as the number of turns on each side. Transformers are of two types: step-down and step-up electrical devices. The step-down transformer lowers the energy of the secondary part (coil). It is made when the number of turns on the primary side is higher than on the secondary side. These types of transformers are used to direct power to electrical devices. Step-up transformers are used in power transfer; they make transmission more efficient by stepping up the voltage, for this reason, maintaining a constant flow of power. The number of turns on the secondary side is higher than on the primary side. The functions of each part of a transformer are discussed below.

## Functions of the Core

The primary purpose of the core of a transformer is to establish a path for magnetic flux. The core's composition determinants are the current, voltage, and frequency. Some of the standard components used in the core are soft iron, air, and steel. Each of the items serves in diverse environments. For instance, transformers made of the air core are employed in areas where the frequencies of the voltage need to be higher than 20 KHz. The iron-core models are used in areas with a frequency below 20 KHz. The soft-iron-core transformers are efficient in occasions where transformers need to be small. Regarding power transfer, the iron-core transformers prove to be better and more efficient power transmitters than the air-core transformers (Winders 57). A transformer that counts its core made of laminated sheets of steel drives away heat more efficiently, thus making it convenient for power transmission.

Laminated-steel cores are used to maximize the efficiency of a transformer. The cores ensure the magnetic flux generated by the transformer is at its best performance. Nonconducting materials are

used to insulate the laminated cores; a good example is a varnish which later makes a core. To establish a core of 2cm thickness, about 40 laminations are used. The principal purpose of the lamination is to reduce losses. The prime causes of core loss are eddy currents and hysteresis. Hysteresis refers to the energy lost due to the reversing of the magnetic field, while eddy currents represent the current losses due to induced flows.

Image showing the core

To determine the copper loss in a transformer, this equation is used.

$$\text{Copper Losses} = I_p R_p + I_s R_s,$$

Where  $I_p$  is the primary current,  $I_s$  is the secondary current,  $R_p$  is the primary resistance, and  $R_s$  is the secondary resistance.

## The function of the Primary Coil

The main coil is the main channel through which the transformer taps energy from the source (alternating current). It serves as the route that all the processes performed by the transformer initiate. The transformer must be connected to a power source to generate changing magnetic fields. The changing magnetic field creates a changing voltage to the primary coil. This justifies how the transformer fulfills its functions (Winders 27). The current (AC) that is passed through the primary coil must find the soft-iron core to generate the magnetic fields. There is a need to note that a transformer has no electrical connections between the primary and the secondary coils. The transmitted voltage to the secondary curl is typically generated due to the changing current in the primary coil. The primary coil is the determinant of the type of transformer to create. When the number of coils in the coil suppresses the secondary coil, the transformer becomes a step-down transformer. A steady increase or decrease in the primary coil's current does not affect the voltage induced in the secondary coil. When the voltage at the primary coil is at its maximum strength, the secondary loop's electric potential is at its lowest level (zero volts). The voltages between the coils accrue to the equation;

$$\text{Primary voltage/ secondary voltage} = \text{turns on primary/turns on secondary},$$

$$V_p/V_s = N_p/N_s$$

For a step-down transformer, the number of winds in the secondary coils is less than in the primary; the opposite defines a step-up transformer.

## The function of the Secondary Coil

The secondary coil acts as the receiver of the load that passes through the primary coil. Depending on the type of transformer, the secondary coil either steps up or down the voltage moving from the

primary coil. The loop works on the ground, and the primary coil generates magnetic fields when the current is passed. Transformers do not function with direct current; hence, the flow type in the primary coil needs to be an alternating current (Koza 727). The effect helps in the creation of magnetic fields which are passed on to the secondary twist. Introducing the magnetic fields in the secondary coil cuts the wires in the coil. Due to the fast cutting, a current is induced into the secondary coil. The current can either be smaller or larger (stepping it down or up). The rate of magnetic field cutting in the secondary coil is influenced by the volume of coils present; this gives the appearance of a mop spread out to clean the ground, as shown in Figure 3.2.

The greater the volume of turns the more current is generated. The above obeys the equation

$$N_p/N_s = V_p/V_s,$$

where N is the number of loops on either side, V is the voltage of both regions, and P/s are primary and secondary, respectively. The main function of the secondary coil is to collect the energy generated by the primary winding and transmit it to the load.

## The Enclosure

A transformer must have its inner parts protected; this is achieved through the use of an enclosure. One of the enclosures used in transformers is the 'hptcover' enclosure. The protecting cover acts as a protective gear for the AC plug-in transformers; it prevents cases of accidental shutdowns in the system. The enclosures must be well-screwed to ensure they are appropriately closed; this helps prevent other environmental factors like rain from destroying the inner components of the machine (Nasar 45).

## The breather

Other components of a converter include the breather and the conservator. The structure acts as a controller for the moisture level. When the temperatures are elevated, the insulation coils tend to expand and contract, creating varying pressure conditions in the conservator (Shook, John, and Liz Swan 44). The breathing space is made of silica gel; crystals that help absorb the atmospheric moisture. The instrument is attached at the end of the breather pipe.

A conservator is an essential tool for the converter. The gadget is used to monitor the level of oil. The drum is fitted on the upper side of the transformer. The instrument is also vented towards the atmosphere at the upper part of the transformer. To enable the proper function of the conservator, oil is not filled to the top. The level is maintained halfway to allow room for expansion and contraction as the temperatures demand. To ensure a continuous flow of the oil to and from the instrument, the main tank is attached to the conservator. The tank is filled with the oil through a pipeline.

Fig.3.3 image showing the different components of the transformer

A transformer deserves care since it is the major source of energy for a large portion of the people living in the world. Maintenance schedules are also conducted to ensure that there is no damage near the transformers. The instrument employs an integrated technology to ensure that all the parts are working as required (O'Kelly 575).

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