

# Transformer

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Section#2

**Abstract-** this is a brief description for transformer and how it works.

## I. DEFINITION

A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled electrical conductors. The mutual induction is a changing current in the primary which creates a changing magnetic field and the changing magnetic field induces a changing voltage in the secondary.

## II. HISTORY

Michael Faraday demonstrated the principle of the transformer in 1831. The transformer is used by Faraday only to demonstrate the principle of electromagnetic induction. The induction coil, which was invented by Irish clergyman Nicholas Callan in 1836, was the first widely used transformer. The first commercial device was built by William Stanley in 1885. The core was made from interlocking E-shaped iron plates. This design was first used commercially in 1886. The first use of the word "transformer" was made by his patent application. The first three phase transformer was developed by the Russian engineer Mikhail Dolivo-Dobrovolsky.

## III. BASIC PRINCIPLES

The transformer is based on two principles:

1. An electric current can produce a magnetic field (electromagnetism).
2. A changing magnetic field within a coil of wire induces a voltage across the ends of the

coil (electromagnetic induction). By changing the current in the primary coil, it changes the strength of its magnetic field, since the changing magnetic field extends into the secondary coil; a voltage is induced across the secondary.

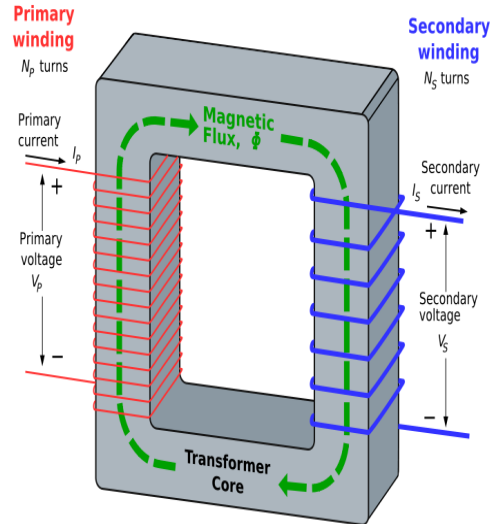


Figure 1. an ideal step-down transformer

The figure shown above is a simplified transformer design. "A current passing through the primary coil creates a magnetic field. The primary and secondary coils are wrapped around a core of very high magnetic permeability, such as iron; this ensures that most of the magnetic field lines produced by the primary current are within the iron and pass through the secondary coil as well as the primary coil."

## IV. EQUIVALENT CIRCUIT

This is the equivalent circuit of a transformer. Figure 2

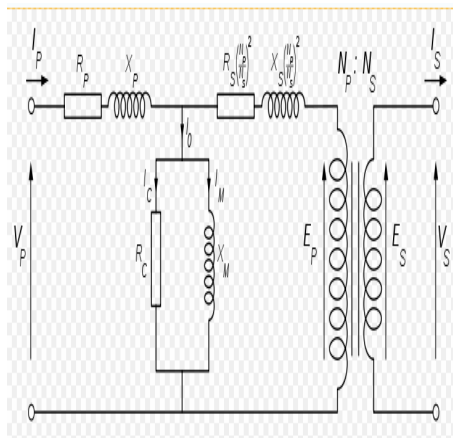


Figure 2. transformer equivalent circuit

Where:

$I_M$  : magnetizing current

$X_M$  : magnetizing reactance

$X_P$  and  $X_S$  :leakage inductances

$R_P$  and  $R_S$  :power loss in the winding

## V. TYPES OF TRANSFORMERS

There are five types of transformers:

1. Autotransformer: it has only a single winding with two end terminals.
2. Polyphase transformers: they are used for three-phase supplies.
3. Leakage transformers: also called a stray-field, there are used for arc welding and high voltage discharge lamps.
4. Resonant transformer: it is a kind of the leakage transformer.
5. Instrument transformer: it is a current transformer device.

Transformers can be classified in different ways:

1. By power level: from a fraction of volt-ampere (VA) to over a thousand MVA.
2. By frequency range: power or radio frequency.

3. By voltage class: from a few volts to hundreds of kilovolts.
4. By cooling type: air cooled, oil filled, fan cooled, or water cooled.
5. By application function: such as power supply, impedance matching, output voltage and current stabilizer, or circuit isolation.
6. By end purpose: such as distribution, rectifier, arc furnace and amplifier output.
7. By winding turns ratio: step-up, step-down, isolating (near equal ratio), variable.

## VI. APPLICATIONS

Transformers are used in many applications. The key application of a transformer is to increase voltage before transmitting electrical energy over long distances through wires. Also, transformers are used extensively in electronic products to step down the supply voltage to a level suitable for the low voltage circuits they contain.

## REFERENCES

- [1] "Transformer." 1-17. <<http://en.wikipedia.org/wiki/Transformer>> (15 Dec. 2008).
- [2] Pansini, Anthony (1999). "Electrical Transformers and Power Equipment." p.23.