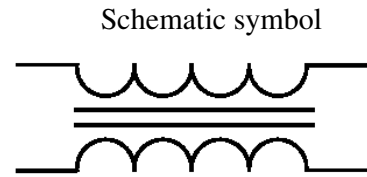


Transformer

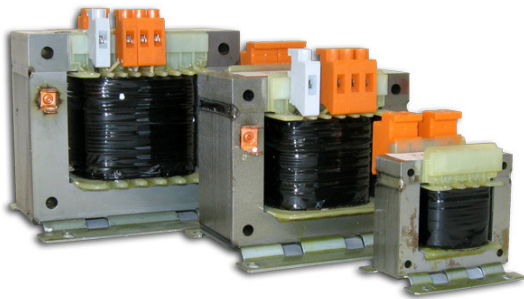
A transformer is a device that has no moving parts and that transfers electrical energy from one circuit to another through inductively coupled conductors — the transformer's coils. Transformer is used to either step-up or step-down alternating voltage while preserving the frequency and keeping the power at a constant level.



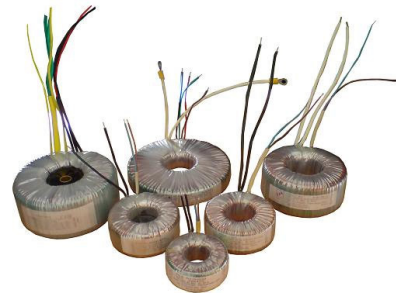
Classification

Transformers can be classified in many different ways; an incomplete list is:

- By power capacity: from a fraction of a volt-ampere (VA) to over a thousand MVA;
- By frequency range: power-, audio-, or radio frequency;
- By voltage class: from a few volts to hundreds of kilovolts;
- By cooling type: air-cooled, oil-filled, fan-cooled, or water-cooled;
- By application: such as power supply, impedance matching, output voltage and current stabilizer, or circuit isolation;
- By purpose: distribution, rectifier, arc furnace, amplifier output, etc.;
- By winding turns ratio: step-up, step-down, isolating with equal or near-equal ratio, variable, multiple windings.



EI transformers



Toroidal transformers

Construction

The typical transformer has two windings insulated electrically from each other. These windings are wound on a common magnetic core made of laminated sheet steel.

1. **Core of transformer** is built from laminated steel cores. Each lamination is insulated from its neighbors by a thin non-conducting layer of insulation. Thinner laminations reduce losses, but are more laborious and expensive to construct.
2. **Primary winding** – input coil, which is used to power the transformer from electrical source.
3. **Secondary winding** – output coil, which is used to power an electrical device. Transformer can have multiple secondary windings.

The principal types of transformer construction are the **core type** and the **shell type**.

Step-down transformation happens when the voltage on the primary winding is greater than the voltage on the secondary winding ($U_1 > U_2$).

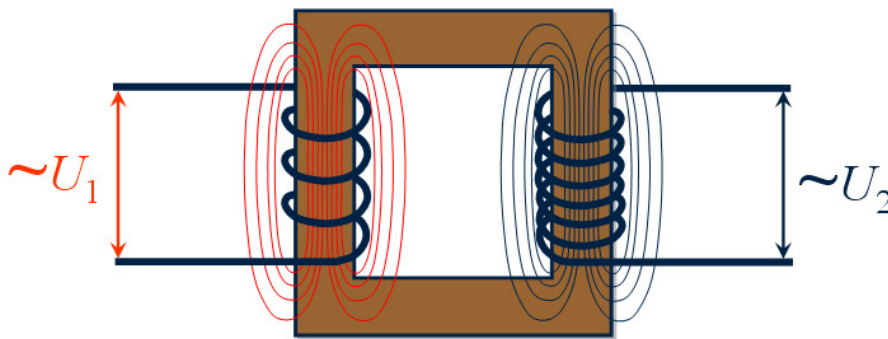
Step-up transformation happens when the voltage on the secondary winding is greater than the voltage on the primary winding ($U_1 < U_2$).

The ratio between primary (U_1) and secondary (U_2) voltages is called transforming ratio (p), thus yielding the ideal power equation:

— — —

The basic principle of transformer

Connecting the primary winding to an alternating power supply (U_1) creates in the transformer core a magnetic flux, which induces voltage in the secondary winding (U_2) with the same frequency (f).



Energy losses

$$P_1 = U_1 I_1 \cos \phi_1$$

$$P_2 = U_2 I_2 \cos \phi_2$$

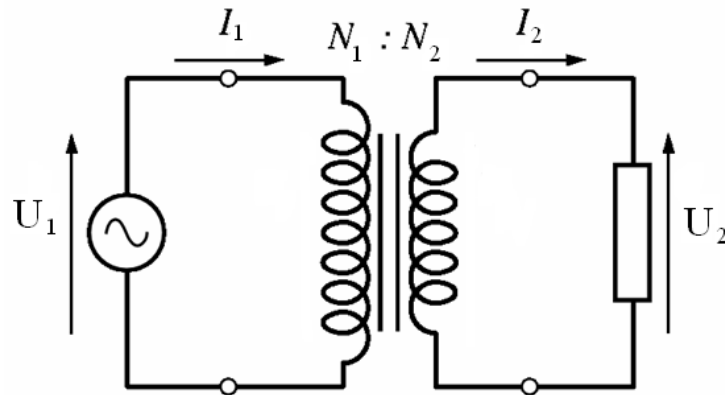
Ideal transformer would have no energy losses. The power input P_1 must equal to the power output P_2 , therefore:

$$\frac{U_2}{U_1} = \frac{I_1}{I_2}$$

In a real transformer however $P_1 > P_2$, and thus the energy is lost in the form of heat

$$Q = UIt = RI^2t$$

The efficiency of transformer: $\eta = \frac{P_2}{P_1} \cdot 100 \%$



In practical transformers energy is dissipated in the windings, core, and surrounding structures. Larger transformers are generally more efficient, and those rated for electricity distribution usually perform better than 98%.

Special transformers

Autotransformer

An autotransformer has a single winding with two end terminals, and one or more terminals at intermediate tap points. The primary voltage is applied across two of the terminals, and the secondary voltage taken from two terminals, almost always having one terminal in common with the primary voltage. The primary and secondary circuits therefore have a number of windings turns in common.

Audio transformers

Audio transformers are those specifically designed for use in audio circuits. They can be used to block radio frequency interference or the DC component of an audio signal, to split or combine audio signals, or to provide impedance matching between high and low impedance circuits, such as between a high impedance tube (valve) amplifier output and a low impedance loudspeaker, or between a high impedance instrument output and the low impedance input of a mixing console.

Instrument transformers

Instrument transformers are used for measuring voltage and current in electrical power systems, and for power system protection and control, where a voltage or current is too large to be conveniently used by an instrument, it can be scaled down to a standardized, low value. A current transformer is a transformer designed to provide a current in its secondary coil proportional to the current flowing in its primary coil.

Voltage transformers, also referred to as "potential transformers", are designed to have an accurately known transformation ratio in both magnitude and phase.

VOCABULARY

inductively coupled conductors – vodiče s indukčnou väzbou

preserving – zachovanie

step down – znižujúci

step up – zvyšujúci

magnitude – veľkosť, rozsah

tube/valve – elektrónka

impedance matching – impedančné prispôsobenie

core – jadro

core type – jadrový (transformátor)

shell type – plášťový (transformátor)

laminated sheet steel – transformátorový plech

surrounding – okolité

neighbor – sused