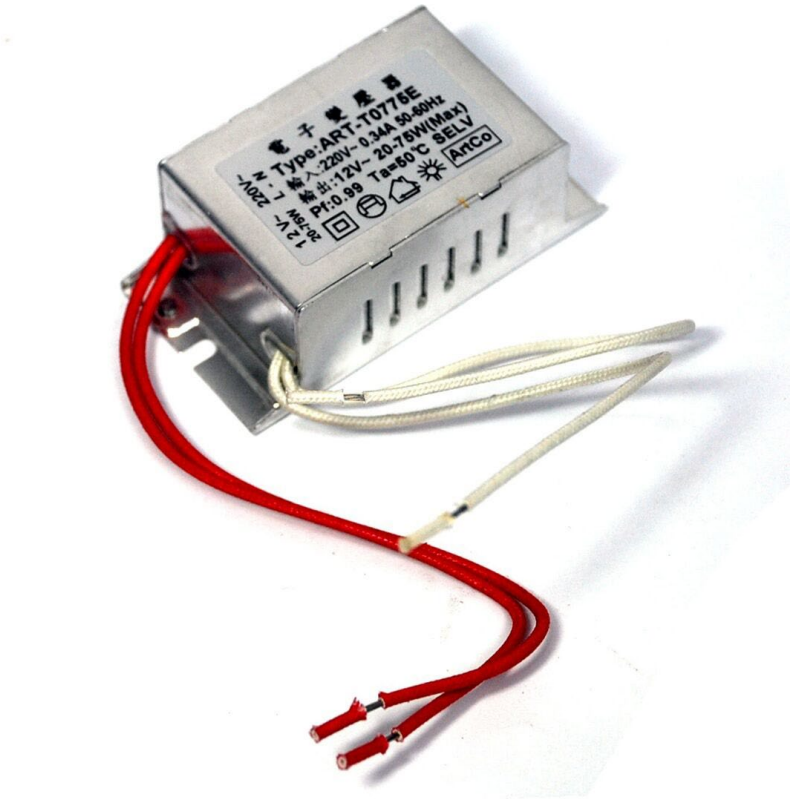
Transformers – Lesson 1



What is a Transformer

- Transformers use electromagnetic induction to transfer energy between two or more circuits

- It changes the voltage level either “stepping up” (increasing) or “stepping down” (decreasing) voltage without changing frequency

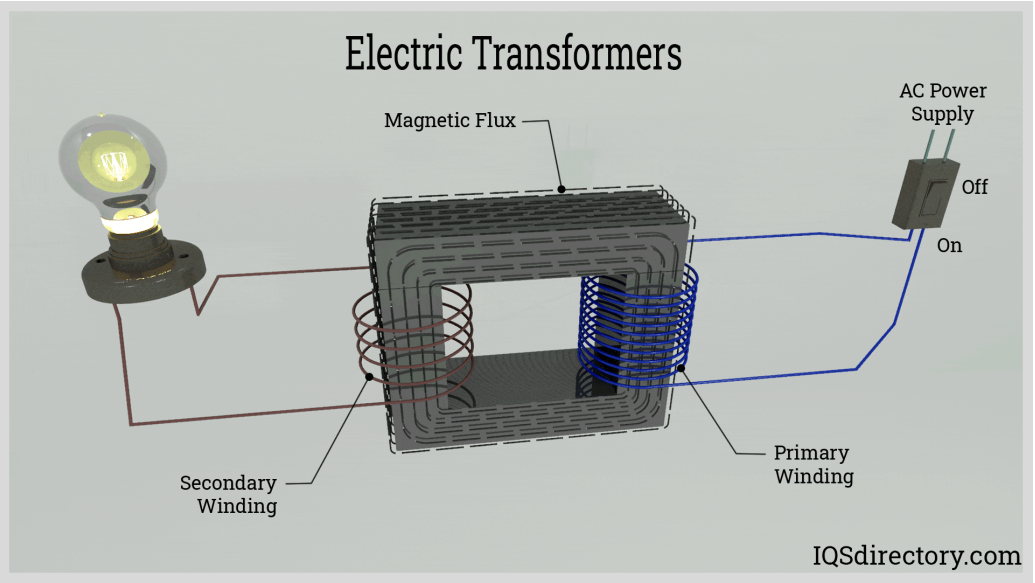


Why are Transformers important

- Step-up transformers are good for long distance power transmission as it reduces current and minimizes power losses in transmission lines
- Transformers allow devices to operate at different voltages whilst using the same grid
- Isolation transformers separate circuits to prevent shocks, equipment damage and interference
- They are very versatile and can be used in all kinds of different systems
- They improve overall energy efficiency by reducing power losses
- They have a long lifespan and require minimal maintenance making them cost effective

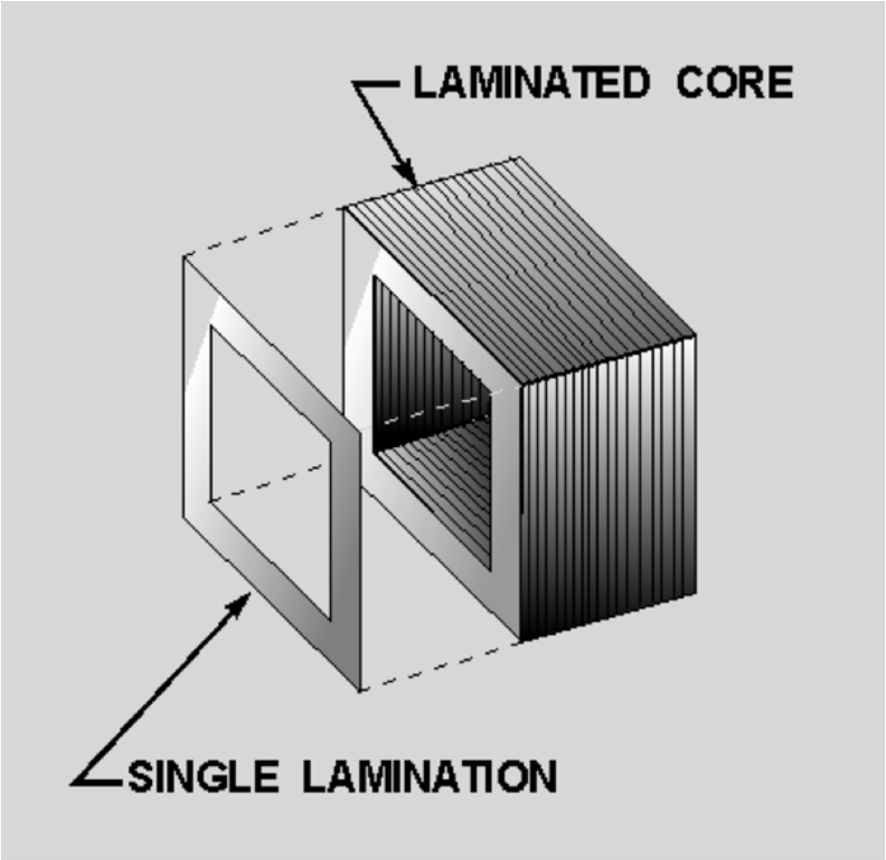
Electronic Transformer Components

- A transformer has three key components:
  - **The Primary Winding** receives the input voltage from the power source and induces a magnetic field
  - **The Secondary Winding** outputs the voltage from the system as the magnetic flux induces a current in the coil
  - **The Core** gets magnetised by the primary winding and transfer the magnetic flux between the primary and the secondary



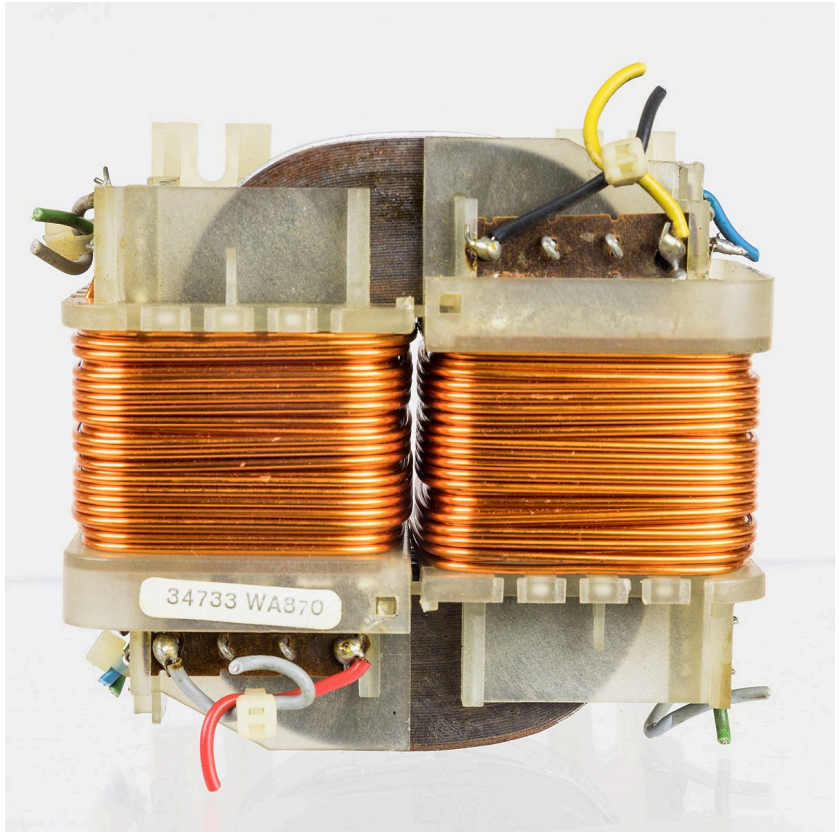
The Core

- The core has a magnetic flux induced in it
- This relies on Faraday's Law or electromagnet induction
- The core is constructed from thin sheets or laminations of ferromagnetic material
- The core isn't entirely necessary, but it helps the magnetic flux to transfer improving efficiency



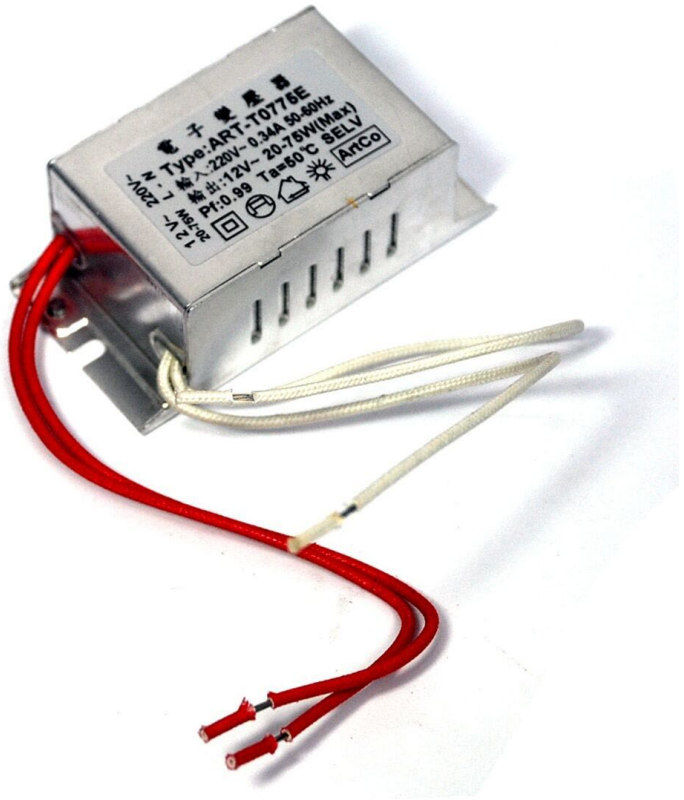
The Windings

- There are two different sets of windings the primary and the secondary
- The amount of “turns” or “loops” in the winding determine the voltage change between the windings
- If the secondary winding has more turns the output voltage increases
- If the primary winding has more turns the output voltage decreases



Purposes of Transformers

- There are 2 main purposes for transformers:
  - **Step up / Step Down**
  - **Isolation Transformers**



Step Up/Step Down

- Step up/down transformers are used for increasing or decreasing voltage to a source
- **Step up transformers** convert from a lower voltage to a higher voltage but also decrease current whilst doing so.
- **Step down transformers** convert from a higher voltage to a lower voltage but also increase current whilst doing so.
- Both are typically used in the national grid and inside of electronic devices to change voltage for transmission/use

Isolation Transformers

- The main goal of isolation transformers isn’t to change the voltage or current but instead to separate two circuits
- They typically don’t change voltage or current by using an equal amount of turns in their windings
- They are typically used to protect components from faults or noise and used to regulate voltage.
- They can change voltage or current it’s just not their main goal

Calculating Change (Voltage) (Ideal)

- The relationship between the amount of turns and the windings voltages can be written as:

  - $\boldsymbol{V_S = V_P * \frac{N_S}{N_P}}$

  - Where:
    - V_P = primary (input) voltage
    - V_S = secondary (output) voltage
    - N_S = number of secondary winding turns
    - N_P = number of primary winding turns

Calculating Change (Current) (Ideal)

- The relationship between the amount of turns and the windings current is the inversely proportional to the voltage

$$\boldsymbol{I_S = I_P * \frac{N_P}{N_S}}$$

- Where:
  - I_P = primary (input) current
  - I_S = secondary (output) current
  - N_S = number of secondary winding turns
  - N_P = number of primary winding turns

Relating Voltage and Current (Ideal)

- The below is only true for an **ideal transformer** which has no power loss.
- We know **Power = Voltage * Current**
- In an ideal transformer: $\boldsymbol{Power_P = Power_S}$
- So, we know that $\boldsymbol{V_P * I_P = V_S * I_S}$
- We can rearrange this to find any of the values when we have the other 3

$$\frac{\boldsymbol{V_P * I_P}}{\boldsymbol{V_S}} = \boldsymbol{I_S}$$