Power Supply Block Diagram

Transformers

Rectifier

Regulator

120V ac
Transformers: Two inductors $L_1, L_2$ placed close to each other. Magnetic flux produced by $L_1$ links to $L_2$ and induces voltage at terminals of $L_2$.

$$n = \frac{N_2}{N_1}, \text{ turns ratio}$$

$L_1$: primary $N_1$ turns
$L_2$: secondary $N_2$ turns

$$v_2(t) = M N_1 N_2 \frac{di_1(t)}{dt}$$

$$M = k \sqrt{L_1 L_2}, \text{ mutual inductance}$$

$k$: coupling coefficient
$$0 \leq k \leq 1$$
Ideal Transformer: $k = 1$, no power loss

\[ v_2(t) = n v_1(t) \quad \text{since } k = 1 \]

No power loss: \[ p(t) = v_1(t) i_1(t) + v_2(t) i_2(t) = 0 \]

\[ \Rightarrow v_2(t) i_2(t) = -v_1(t) i_1(t) \]

\[ \Rightarrow i_2(t) = -\frac{v_1(t)}{v_2(t)} i_1(t) = -\frac{1}{n} i_1(t) \]

As voltage goes down, current goes up and vice versa.
Example: 115 Vac to 9 Vac, 1 A ac transforms

\[ n = \frac{v_2(t)}{v_1(t)} = \frac{9 V}{115 V} = 0.078 \]

\[ i_2(t) = 1 A = -\frac{1}{n} i_1(t) \Rightarrow i_1(t) = -n i_2(t) = -0.078 A \text{ ac} \]

Transformers uses 115 Vac, 78 mA ac on primary side to deliver 9 Vac, 1 A ac on secondary side.

Primary and secondary side are electrically isolated; energy is transferred through magnetic field.