Power Electronics Reference

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Contents

Introduction

Just throwing together some concepts and examples for later reference

1 General Equations

1.1 Power and Energy

1.1.1 Instantaneous Power

This value is a positive real number if the element is supplying power, or is a negative real number if the element is consuming power.

$$p(t) = v(t)i(t) \quad (W)$$

- $\boldsymbol{p(t)}$:= Instantaneous Power (W)
- $\boldsymbol{v(t)}$:= Instantaneous Voltage (V)
- $\boldsymbol{i(t)}$:= Instantaneous Current (A)

1.1.2 Average Power

$$P = \frac{1}{T}\int_{t_o}^{t_o+T} p(t)dt \quad (W)$$

$$P = \frac{1}{T}\int_{t_o}^{t_o+T} v(t)i(t)dt \quad (W)$$

$$P = \frac{W}{T} \quad (W)$$

- $\boldsymbol{P}$:= Average Power (W)
- $\boldsymbol{p(t)}$:= Instantaneous Power (W)
- $\boldsymbol{v(t)}$:= Instantaneous Voltage (V)
- $\boldsymbol{i(t)}$:= Instantaneous Current (A)
- $\boldsymbol{T}$:= Time Period (Δs)
- $\boldsymbol{t_o}$:= Initial Time (s)
- $\boldsymbol{W}$:= Work (J)

1.1.3 Energy

$$W = \int_{t_1}^{t_2} p(t)dt \quad (J)$$

- $\boldsymbol{W}$:= Work (J)
- $\boldsymbol{p(t)}$:= Instantaneous Power (W)

1.2 Inductors

1.2.1 Current/Voltage Relationship

$$i_L(t_o + T) = \frac{1}{L}\int_{t_o}^{t_o+T} v_L(t)dt + i(t_o)$$

- $\boldsymbol{i_L(t)}$:= Instantaneous Current Through an Inductor (A)
- $\boldsymbol{v_L(t)}$:= Instantaneous Voltage Across an Inductor (V)
- $\boldsymbol{i(t_o)}$:= Initial Current at Time t_o (A)
- $\boldsymbol{L}$:= Inductance (H)
- $\boldsymbol{t_o}$:= Initial Time (s)
- $\boldsymbol{T}$:= Time Period (Δs)

$$V_L = \frac{1}{T}\int_{t_o}^{t_o+T} v_L(t)dt$$

NOTE: When a sinusoidal current is applied through the inductor, the average voltage is zero ($V_L = 0$) for each period.

- $\boldsymbol{V_L}$:= Average Voltage Across and Inductor (V)
- $\boldsymbol{v_L(t)}$:= Instantaneous Voltage Across an Inductor (V)
- $\boldsymbol{t_o}$:= Initial Time (s)
- $\boldsymbol{T}$:= Time Period (Δs)

1.2.2 Power and Energy

$$w_L(t) = \frac{1}{2} L i_L^2(t)$$

- $\boldsymbol{w_L(t)}$:= Instantaneous Work an Inductor Does at Time t (J)
- $\boldsymbol{i_L(t)}$:= Instantaneous Current Through an Inductor (A)
- $\boldsymbol{L}$:= Inductance (H)

$$P_L = \frac{1}{T} \int {t_o}^{t_o+T} p_L(t) dt$$

NOTE: The average power produced/consumed by the inductor is zero ($P_L = 0$) for each period when a periodic current is applied through the inductor.

- $\boldsymbol{P_L}$:= Average Power an Inductor Produces/Consumes (W)
- $\boldsymbol{p_L(t)}$:= Instantaneous Power an Inductor Produces/Consumes (W)
- $\boldsymbol{t_o}$:= Initial Time (s)
- $\boldsymbol{T}$:= Time Period (Δs)

1.3 RMS Values

$$V_{RMS} = \sqrt{\frac{1}{T}\int_{t_o}^{t_o+T} v^2(t)dt}$$

$$I_{RMS} = \sqrt{\frac{1}{T}\int_{t_o}^{t_o+T} i^2(t)dt}$$

- $\boldsymbol{V_{RMS}}$:= RMS Voltage (V)
- $\boldsymbol{I_{RMS}}$:= RMS Current (A)
- $\boldsymbol{t_o}$:= Initial Time (s)
- $\boldsymbol{T}$:= Time Period (Δs)

Variables

$\boldsymbol{C}$ Capacitance (F).
$\boldsymbol{I}$ Average Current (A).
$\boldsymbol{I_C}$ Average Current Through a Capacitor(A).
$\boldsymbol{I_L}$ Average Current Through an Inductor (A).
$\boldsymbol{I_{RMS}}$ RMS Current (A).
$\boldsymbol{L}$ Inductance (H).
$\boldsymbol{P}$ Average Power (W).
$\boldsymbol{P_C}$ Average Power a Capacitor Produces/Consumes (W).
$\boldsymbol{P_L}$ Average Power an Inductor Produces/Consumes (W).
$\boldsymbol{T}$ Time Period (Δs).
$\boldsymbol{V}$ Average Voltage (V).
$\boldsymbol{V_C}$ Average Voltage Across a Capacitor (V).
$\boldsymbol{V_L}$ Average Voltage Across and Inductor (V).
$\boldsymbol{V_{RMS}}$ RMS Voltage (V).
$\boldsymbol{W}$ Work (J).
$\boldsymbol{W_C}$ Work a Capacitor Does over a Period of Time (J).
$\boldsymbol{W_L}$ Work an Inductor Does over a Period of Time (J).
$\boldsymbol{i(t)}$ Instantaneous Current (A).
$\boldsymbol{i(t_o)}$ Initial Current at Time t_o (A).
$\boldsymbol{i_C(t)}$ Instantaneous Current Through a Capacitor (A).
$\boldsymbol{i_L(t)}$ Instantaneous Current Through an Inductor (A).
$\boldsymbol{p(t)}$ Instantaneous Power (W).
$\boldsymbol{p_C(t)}$ Instantaneous Power a Capacitor Produces/Consumes (W).
$\boldsymbol{p_L(t)}$ Instantaneous Power an Inductor Produces/Consumes (W).
$\boldsymbol{t_o}$ Initial Time (s).
$\boldsymbol{v(t)}$ Instantaneous Voltage (V).
$\boldsymbol{v(t_o)}$ Initial Voltage at Time t_o (V).
$\boldsymbol{v_C(t)}$ Instantaneous Voltage Across a Capacitor (V).
$\boldsymbol{v_L(t)}$ Instantaneous Voltage Across an Inductor (V).
$\boldsymbol{w_L(t)}$ Instantaneous Work a Capacitor Does at Time t (J).
$\boldsymbol{w_L(t)}$ Instantaneous Work an Inductor Does at Time t (J).
$\boldsymbol{t}$ Instantaneous Time (s).

Glossary

Average Current The average current going through a reference point throughout a period of time T.
Average Power The average power an element is consuming or producing throughout a period of time T.
Average Voltage The average voltage across two reference points throughout a period of time T.

Capacitance A measurement of the phenomenon that change in voltage is resisted in a capacitor dut to the establishment of an electric field.

Inductance A measurement of the phenomenon that change in current is resisted in an inductor due to the establishment of a magnetic field.
Initial Time Describes the initial time that a period in time is taken.
Instantaneous Current The current going through a reference point at time t.
Instantaneous Power The power an element is consuming or producing at time t.
Instantaneous Time An instant in time.
Instantaneous Voltage The voltage across two reference points at time t.

Time Period A period between two points in time. Usually describes a full period in a sinusoidal wave.

Work The power a system is able to output over a period in time.

Index