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Choppers Formulas

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List of 30 Choppers Formulas

Choppers

Chopper Core Factors

1) AC Ripple Voltage

Open Calculator

fx $$V_r = \sqrt{V_{rms}^2 - V_L^2}$$

ex $$39.97612V = \sqrt{(44.7V)^2 - (20V)^2}$$

2) Chopping Frequency

Open Calculator

fx $$f_c = \frac{d}{T_{on}}$$

ex $$1.175556Hz = \frac{0.529}{0.45s}$$

3) Chopping Period

Open Calculator

fx $$T = T_{on} + T_c$$

ex $$0.85s = 0.45s + 0.4s$$

4) Critical Capacitance

Open Calculator

$$C_o = \left(\frac{I_{out}}{2 \cdot V_s}\right) \cdot \left(\frac{1}{f_{max}}\right)$$

$$0.001126F = \left(\frac{0.5A}{2 \cdot 100V}\right) \cdot \left(\frac{1}{2.22Hz}\right)$$

5) Critical Inductance

Open Calculator

$$L = V_L^2 \cdot \left(\frac{V_s - V_L}{2 \cdot f_c \cdot V_s \cdot P_L}\right)$$

$$60.60606H = (20V)^2 \cdot \left(\frac{100V - 20V}{2 \cdot 0.44Hz \cdot 100V \cdot 6W}\right)$$

6) Duty Cycle

Open Calculator

$$d = \frac{T_{on}}{T}$$

$$0.529412 = \frac{0.45s}{0.85s}$$

7) Effective Input Resistance

Open Calculator

$$R_{in} = \frac{R}{d}$$

$$75.61437\Omega = \frac{40\Omega}{0.529}$$

8) Energy Input to Inductor from Source

Open Calculator

$$W_{in} = V_s \cdot \left(\frac{I_1 + I_2}{2} \right) \cdot T_{on}$$

$$585\text{J} = 100\text{V} \cdot \left(\frac{12\text{A} + 14\text{A}}{2} \right) \cdot 0.45\text{s}$$

9) Energy Released by Inductor to Load

Open Calculator

$$W_{off} = (V_o - V_{in}) \cdot \left(\frac{I_1 + I_2}{2} \right) \cdot T_c$$

$$652.34\text{J} = (125.7\text{V} - 0.25\text{V}) \cdot \left(\frac{12\text{A} + 14\text{A}}{2} \right) \cdot 0.4\text{s}$$

10) Excess Work Due to Thyristor 1 in Chopper Circuit

Open Calculator

$$W = 0.5 \cdot L_m \cdot \left(\left(I_{out} + \frac{t_{rr} \cdot V_c}{L_m} \right) - I_{out}^2 \right)$$

$$40.52625\text{J} = 0.5 \cdot 0.21\text{H} \cdot \left(\left(0.5\text{A} + \frac{1.8\text{s} \cdot 45\text{V}}{0.21\text{H}} \right) - (0.5\text{A})^2 \right)$$

11) Maximum Ripple Current Resistive Load

Open Calculator

$$I_r = \frac{V_s}{4 \cdot L \cdot f_c}$$

$$0.937594\text{A} = \frac{100\text{V}}{4 \cdot 60.6\text{H} \cdot 0.44\text{Hz}}$$

12) Peak to Peak Ripple Voltage of Capacitor

Open Calculator

fx $$\Delta V_c = \left(\frac{1}{C}\right) \cdot \int\left(\left(\frac{\Delta I}{4}\right) \cdot x, x, 0, \frac{t}{2}\right)$$

ex $$2.782555V = \left(\frac{1}{2.34F}\right) \cdot \int\left(\left(\frac{3.964A}{4}\right) \cdot x, x, 0, \frac{7.25s}{2}\right)$$

13) Ripple Factor of DC Chopper

Open Calculator

fx $$RF = \sqrt{\left(\frac{1}{d}\right) - d}$$

ex $$1.166773 = \sqrt{\left(\frac{1}{0.529}\right) - 0.529}$$

Commutated Chopper

14) Average Output Voltage in Load Commutated Chopper

Open Calculator

fx $$V_{avg} = \frac{2 \cdot V_{in}^2 \cdot C_c \cdot f_c}{I_{out}}$$

ex $$0.01375V = \frac{2 \cdot (0.25V)^2 \cdot 0.125F \cdot 0.44Hz}{0.5A}$$

15) Average Value of Output Voltage using Chopping Period

Open Calculator

$$V_{avg} = V_{in} \cdot \frac{T_{on} - T_c}{T}$$

$$0.014706\text{V} = 0.25\text{V} \cdot \frac{0.45\text{s} - 0.4\text{s}}{0.85\text{s}}$$

16) Circuit Turn Off Time for Main SCR in Chopper

Open Calculator

$$T_c = \frac{1}{\omega_o} \cdot (\pi - 2 \cdot \theta_1)$$

$$0.405954\text{s} = \frac{1}{7.67\text{rad/s}} \cdot (\pi - 2 \cdot 0.8^\circ)$$

17) Maximum Chopping Frequency in Load Commutated Chopper

Open Calculator

$$f_{max} = \frac{1}{T_{on}}$$

$$2.222222\text{Hz} = \frac{1}{0.45\text{s}}$$

18) Peak Capacitor Current in Voltage Commutated Chopper

Open Calculator

$$I_{cp} = \frac{V_s}{\omega_o \cdot L_c}$$

$$1.862544\text{A} = \frac{100\text{V}}{7.67\text{rad/s} \cdot 7\text{H}}$$

19) Peak Diode Current of Voltage Commutated Chopper

Open Calculator

fx $$i_{dp} = V_s \cdot \sqrt{\frac{C}{L}}$$

ex $$19.65041\text{A} = 100\text{V} \cdot \sqrt{\frac{2.34\text{F}}{60.6\text{H}}}$$

20) Total Commutation Interval in Load Commutated Chopper

Open Calculator

fx $$T_{ci} = \frac{2 \cdot C \cdot V_s}{I_{out}}$$

ex $$936\text{s} = \frac{2 \cdot 2.34\text{F} \cdot 100\text{V}}{0.5\text{A}}$$

Step Up/Step Down Chopper

21) Average Load Voltage for Step down Chopper (Buck Converter)

Open Calculator

fx $$V_{L(bu)} = d \cdot V_s$$

ex $$52.9\text{V} = 0.529 \cdot 100\text{V}$$

22) Average Load Voltage for Step up Chopper (Boost Converter)

Open Calculator

fx $$V_{L(bo)} = \left(\frac{1}{1-d}\right) \cdot V_s$$

ex $$212.3142\text{V} = \left(\frac{1}{1-0.529}\right) \cdot 100\text{V}$$

23) Average Load Voltage for Step up or Step down Chopper (Buck-Boost Converter)

Open Calculator

fx $$V_{L(bu\text{-}bo)} = V_s \cdot \left(\frac{d}{1-d}\right)$$

ex $$112.3142V = 100V \cdot \left(\frac{0.529}{1-0.529}\right)$$

24) Average Load Voltage Step down Chopper (Buck Converter)

Open Calculator

fx $$V_L = f_c \cdot T_{on} \cdot V_s$$

ex $$19.8V = 0.44Hz \cdot 0.45s \cdot 100V$$

25) Average Output Current for Step down Chopper (Buck Converter)

Open Calculator

fx $$i_{o(bu)} = d \cdot \left(\frac{V_s}{R}\right)$$

ex $$1.3225A = 0.529 \cdot \left(\frac{100V}{40\Omega}\right)$$

26) Capacitor Voltage of Buck Converter

Open Calculator

fx $$V_{cap} = \left(\frac{1}{C}\right) \cdot \int (i_C \cdot x, x, 0, 1) + V_C$$

ex $$4.832692V = \left(\frac{1}{2.34F}\right) \cdot \int (2.376A \cdot x, x, 0, 1) + 4.325V$$

27) Input Power for Step down Chopper

Open Calculator

$$P_{in(bu)} = \left(\frac{1}{T_{tot}}\right) \cdot \int\left(\left(V_s \cdot \left(\frac{V_s - V_d}{R}\right)\right), x, 0, (d \cdot T_{tot})\right)$$

ex

$$128.9438W = \left(\frac{1}{1.2s}\right) \cdot \int\left(\left(100V \cdot \left(\frac{100V - 2.5V}{40\Omega}\right)\right), x, 0, (0.529 \cdot 1.2s)\right)$$

28) Output Power Step down Chopper (Buck Converter)

Open Calculator

$$P_{out(bu)} = \frac{d \cdot V_s^2}{R}$$

$$132.25W = \frac{0.529 \cdot (100V)^2}{40\Omega}$$

29) RMS Load Voltage for Step down Chopper (Buck Converter)

Open Calculator

$$V_{rms(bu)} = \sqrt{d} \cdot V_s$$

$$72.73239V = \sqrt{0.529} \cdot 100V$$

30) RMS Output Current for Step down Chopper (Buck Converter)

Open Calculator

$$I_{rms(bu)} = \sqrt{d} \cdot \left(\frac{V_s}{R}\right)$$

$$1.81831A = \sqrt{0.529} \cdot \left(\frac{100V}{40\Omega}\right)$$

Variables Used

- **C** Capacitance *(Farad)*
- C_c Commutation Capacitance *(Farad)*
- C_o Critical Capacitance *(Farad)*
- **d** Duty Cycle
- f_c Chopping Frequency *(Hertz)*
- f_{max} Maximum Frequency *(Hertz)*
- I_1 Current 1 *(Ampere)*
- I_2 Current 2 *(Ampere)*
- i_C Current Across Capacitor *(Ampere)*
- I_{cp} Peak Capacitor Current *(Ampere)*
- i_{dp} Peak Diode Current *(Ampere)*
- $i_{o(bu)}$ Average Output Current Buck Converter *(Ampere)*
- I_{out} Output Current *(Ampere)*
- I_r Ripple Current *(Ampere)*
- $I_{rms(bu)}$ RMS Current Buck Converter *(Ampere)*
- **L** Inductance *(Henry)*
- L_c Commutating Inductance *(Henry)*
- L_m Limiting Inductance *(Henry)*
- $P_{in(bu)}$ Input Power Buck Converter *(Watt)*
- P_L Load Power *(Watt)*
- $P_{out(bu)}$ Output Power Buck Converter *(Watt)*
- **R** Resistance *(Ohm)*
- R_{in} Input Resistance *(Ohm)*

- **RF** Ripple Factor
- **t** Time *(Second)*
- **T** Chopping Period *(Second)*
- T_c Circuit Turn Off Time *(Second)*
- T_{ci} Total Commutation Interval *(Second)*
- T_{on} Chopper On Time *(Second)*
- t_{rr} Reverse Recovery Time *(Second)*
- T_{tot} Total Switching Period *(Second)*
- V_{avg} Average Output Voltage *(Volt)*
- V_c Capacitor Commutation Voltage *(Volt)*
- V_C Initial Capacitor Voltage *(Volt)*
- V_{cap} Capacitor Voltage *(Volt)*
- V_d Chopper Drop *(Volt)*
- V_{in} Input Voltage *(Volt)*
- V_L Load Voltage *(Volt)*
- $V_{L(bo)}$ Average Load Voltage Step Up Chopper *(Volt)*
- $V_{L(bu)}$ Average Load Voltage Step Down Chopper *(Volt)*
- $V_{L(bu\text{-}bo)}$ Average Load Voltage StepUp/Down Chopper *(Volt)*
- V_o Output Voltage *(Volt)*
- V_r Ripple Voltage *(Volt)*
- V_{rms} RMS Voltage *(Volt)*
- $V_{rms(bu)}$ RMS Voltage Buck Converter *(Volt)*
- V_s Source Voltage *(Volt)*
- **W** Excess Work *(Joule)*
- W_{in} Energy Input *(Joule)*

- W_{off} Energy Released *(Joule)*
- ΔI Change in Current *(Ampere)*
- ΔV_c Ripple Voltage in Buck Converter *(Volt)*
- θ_1 Commutation Angle *(Degree)*
- ω_o Resonant Frequency *(Radian per Second)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **int**, int(expr, arg, from, to)
  The definite integral can be used to calculate net signed area, which is the area above the x -axis minus the area below the x -axis.
- Function: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Electric Current** in Ampere (A)
  Electric Current Unit Conversion
- Measurement: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Capacitance** in Farad (F)
  Capacitance Unit Conversion
- Measurement: **Electric Resistance** in Ohm (Ω)
  Electric Resistance Unit Conversion
- Measurement: **Inductance** in Henry (H)
  Inductance Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion

- Measurement: **Angular Frequency** in Radian per Second (rad/s)
  Angular Frequency Unit Conversion

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