Important Choppers Formulas PDF

Formulas
Examples
with Units

List of 30
Important Choppers Formulas

1) Chopper Core Factors Formulas

1.1) AC Ripple Voltage Formula

Evaluate Formula

Formula

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

Example with Units

$$39.9761\,\text{V} = \sqrt{44.7\,\text{V}^2 - 20\,\text{V}^2}$$

1.2) Chopping Frequency Formula

Evaluate Formula

Formula

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

Example with Units

$$1.1756\,\text{Hz} = \frac{0.529}{0.45\,\text{s}}$$

1.3) Chopping Period Formula

Evaluate Formula

Formula

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

Example with Units

$$0.85\,\text{s} = 0.45\,\text{s} + 0.4\,\text{s}$$

1.4) Critical Capacitance Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0011\,\text{F} = \left(\frac{0.5\,\text{A}}{2 \cdot 100\,\text{V}}\right) \cdot \left(\frac{1}{2.22\,\text{Hz}}\right)$$

1.5) Critical Inductance Formula

Evaluate Formula

Formula

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

Example with Units

$$60.6061\,\text{H} = 20\,\text{V}^2 \cdot \left(\frac{100\,\text{V} - 20\,\text{V}}{2 \cdot 0.44\,\text{Hz} \cdot 100\,\text{V} \cdot 6\,\text{W}}\right)$$

1.6) Duty Cycle Formula

Evaluate Formula

Formula

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

Example with Units

$$0.5294 = \frac{0.45\,\text{s}}{0.85\,\text{s}}$$

1.7) Effective Input Resistance Formula

Evaluate Formula

Formula

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

Example with Units

$$75.6144\,\Omega = \frac{40\,\Omega}{0.529}$$

1.8) Energy Input to Inductor from Source Formula

Evaluate Formula

Formula

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

Example with Units

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

1.9) Energy Released by Inductor to Load Formula

Evaluate Formula

Formula

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

Example with Units

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

1.10) Excess Work Due to Thyristor 1 in Chopper Circuit Formula

Evaluate Formula

Formula

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

Example with Units

$$40.5262\,J = 0.5 \cdot 0.21\,H \cdot \left(\left(0.5\,A + \frac{1.8\,s \cdot 45\,V}{0.21\,H}\right) - 0.5\,A^{\,2}\right)$$

1.11) Maximum Ripple Current Resistive Load Formula

Evaluate Formula

Formula

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

Example with Units

$$0.9376\,A = \frac{100\,V}{4 \cdot 60.6\,H \cdot 0.44\,Hz}$$

1.12) Peak to Peak Ripple Voltage of Capacitor Formula

Evaluate Formula

Formula

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

Example with Units

$$2.7826\,\text{V} = \left(\frac{1}{2.34\,\text{F}}\right) \cdot \int\left(\left(\frac{3.964\,\text{A}}{4}\right) \cdot x, x, 0, \frac{7.25\,\text{s}}{2}\right)$$

1.13) Ripple Factor of DC Chopper Formula

Evaluate Formula

Formula

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

Example

$$1.1668 = \sqrt{\left(\frac{1}{0.529}\right) - 0.529}$$

2) Commutated Chopper Formulas

2.1) Average Output Voltage in Load Commutated Chopper Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0138\,\text{V} = \frac{2 \cdot 0.25\,\text{V}^2 \cdot 0.125\,\text{F} \cdot 0.44\,\text{Hz}}{0.5\,\text{A}}$$

2.2) Average Value of Output Voltage using Chopping Period Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0147\,\text{V} = 0.25\,\text{V} \cdot \frac{0.45\,\text{s} - 0.4\,\text{s}}{0.85\,\text{s}}$$

2.3) Circuit Turn Off Time for Main SCR in Chopper Formula

Evaluate Formula

Formula

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

Example with Units

$$0.406\,\text{s} = \frac{1}{7.67\,\text{rad/s}} \cdot \left(3.1416 - 2 \cdot 0.8°\right)$$

2.4) Maximum Chopping Frequency in Load Commutated Chopper Formula

Evaluate Formula

Formula

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

Example with Units

$$2.2222\,\text{Hz} = \frac{1}{0.45\,\text{s}}$$

2.5) Peak Capacitor Current in Voltage Commutated Chopper Formula

Evaluate Formula

Formula

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

Example with Units

$$1.8625\,\text{A} = \frac{100\,\text{V}}{7.67\,\text{rad/s} \cdot 7\,\text{H}}$$

2.6) Peak Diode Current of Voltage Commutated Chopper Formula

Evaluate Formula

Formula

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

Example with Units

$$19.6504\,\text{A} = 100\,\text{V} \cdot \sqrt{\frac{2.34\,\text{F}}{60.6\,\text{H}}}$$

2.7) Total Commutation Interval in Load Commutated Chopper Formula

Evaluate Formula

Formula

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

Example with Units

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

3) Step Up/Step Down Chopper Formulas

3.1) Average Load Voltage for Step down Chopper (Buck Converter) Formula

Evaluate Formula

Formula

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

Example with Units

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

3.2) Average Load Voltage for Step up Chopper (Boost Converter) Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

3.4) Average Load Voltage Step down Chopper (Buck Converter) Formula

Evaluate Formula

Formula

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

Example with Units

$$19.8\,\text{V} = 0.44\,\text{Hz} \cdot 0.45\,\text{s} \cdot 100\,\text{V}$$

3.5) Average Output Current for Step down Chopper (Buck Converter) Formula

Evaluate Formula

Formula

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

Example with Units

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

3.6) Capacitor Voltage of Buck Converter Formula

Evaluate Formula

Formula

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

Example with Units

$$4.8327\,\text{V} = \left(\frac{1}{2.34\,\text{F}} \right) \cdot \int \left(2.376\,\text{A} \cdot x, x, 0, 1 \right) + 4.325\,\text{V}$$

3.7) Input Power for Step down Chopper Formula

Evaluate Formula

Formula

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

Example with Units

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

3.8) Output Power Step down Chopper (Buck Converter) Formula

Evaluate Formula

Formula

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

Example with Units

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

3.9) RMS Load Voltage for Step down Chopper (Buck Converter) Formula

Evaluate Formula

Formula

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

Example with Units

$$72.7324\,\text{V} = \sqrt{0.529} \cdot 100\,\text{V}$$

3.10) RMS Output Current for Step down Chopper (Buck Converter) Formula

Evaluate Formula

Formula

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

Example with Units

$$1.8183\,\text{A} = \sqrt{0.529} \cdot \left(\frac{100\,\text{V}}{40\,\Omega} \right)$$

Variables used in list of Choppers Formulas above

- **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)*

Constants, Functions, Measurements used in list of Choppers Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **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.*
- Functions: **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*

- 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)*
- $V_{L(bu-bo)}$ 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)*

Download other Important Power Electronics PDFs

- Important Advanced Transistor Devices Formulas
- Important Basic Transistor Devices Formulas
- Important Choppers Formulas
- Important Controlled Rectifiers Formulas
- Important DC Drives Formulas
- Important Inverters Formulas
- Important Silicon Controlled Rectifier Formulas
- Important Switching Regulator Formulas
- Important Uncontrolled Rectifiers Formulas

Try our Unique Visual Calculators

- Reverse percentage
- HCF calculator
- Simple fraction

Please SHARE this PDF with someone who needs it!

This PDF can be downloaded in these languages

English Spanish French German Russian Italian Portuguese Polish Dutch

7/8/2024 | 12:13:25 PM UTC