

Simulation Study of Voltage & Current Commutated Chopper

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Abstract: In this project we study the simulation of Current Commutated Chopper and Voltage Commutated Chopper. We also study the control strategies of Current & Voltage Commutated Chopper. This control techniques are working by two types;-1). Pulse width modulation controller constant frequency operation. 2). Variable frequency control

Keywords: Power Quality, inductor, capacitor, Switch mode power supply (SMPS), chopper

1. Introduction

Converting the unregulated DC input to a controlled DC output with a desired voltage level. A chopper is a static device which is used to obtain a variable dc voltage from a constant dc voltage source. A chopper is also known as dc-to-dc converter. The thyristor converter offers greater Efficiency, faster response, lower maintenance, smaller size and smooth control. Choppers are widely used in trolley cars battery operated vehicles, traction motor control, control of large number of dc motors, etc.

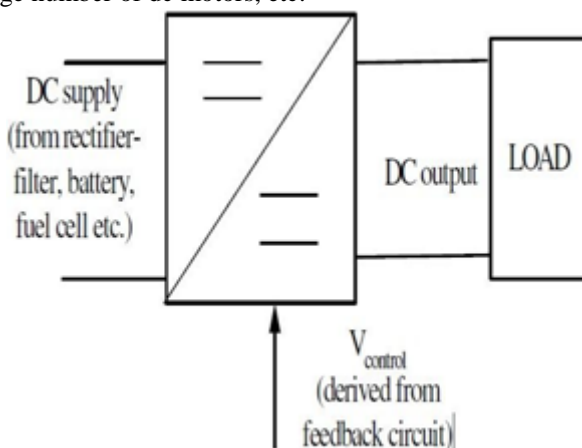


Figure 1.1: General Block Diagram

1.1 Applications

Switched-mode power supply (SMPS), DC motor control, battery Charger.

2. Classification of Choppers

Choppers are of two types:

- 1) Step-down choppers
- 2) Step-up choppers

In step down chopper output voltage is less than input Voltage In step up chopper output voltage is more than input voltage.

2.1 Principle of Step-down Chopper

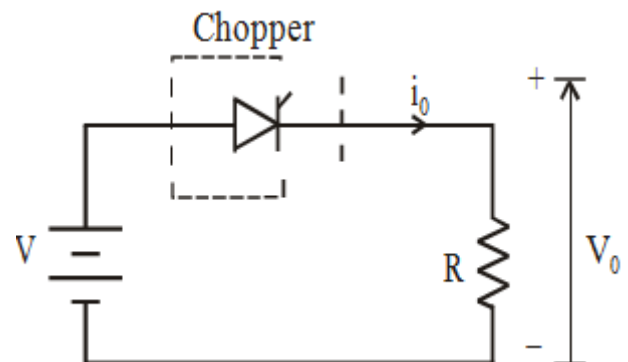


Figure 2.1: Step-down Chopper

Fig. 2.1 shows a step-down chopper with resistive load. The thyristor in the circuit acts as a switch. When thyristor is ON, supply voltage appears across the load and when thyristor is OFF, the voltage across the load will be zero.

2.2 Principle of Step-up Chopper

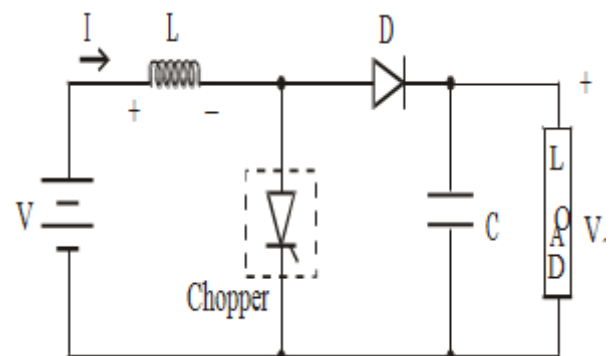


Figure 2.2: step-up chopper

Step-up chopper is used to obtain a load voltage higher than V_o . The input voltage V . The values of L and C are chosen depending upon their requirement of output voltage and Current. When the chopper is ON, the inductor L is connected across the supply. The inductor current ' I ' rises and the Inductor stores energy during the ON time of the chopper, t_{ON} . When the chopper is off, the inductor current I is forced to flow through the diode D and load for a period,

t_{OFF} . The current tends to decrease resulting in reversing the polarity of induced EMF in L . Therefore voltage across load is given By:-

$$V_o = V + L \frac{dI}{dt} \text{ i.e. } V_o > V$$

3. Control Strategies

The output dc voltage can be varied by the following methods.

1. Pulse width modulation control or constant frequency operation.
2. Variable frequency control

3.1 Pulse Width Modulation

T_{ON} is varied keeping chopping frequency f & chopping period ' T ' constant Output voltage is varied by varying the ON time t_{ON}

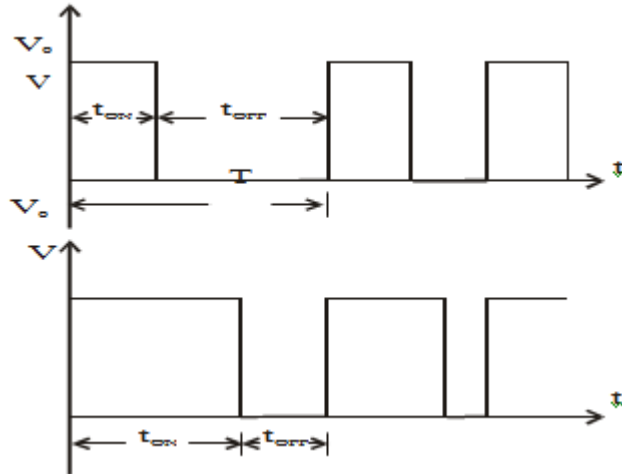


Figure 3.1: Pulse width modulation Waveform

3.2 Variable Frequency Control

Chopping frequency ' f ' is varied keeping either t_{ON} or t_{OFF} constant. To obtain full output voltage range, frequency has to be varied over a wide range. This method produces harmonics in the output and for large t_{OFF} load current may be come discontinuous

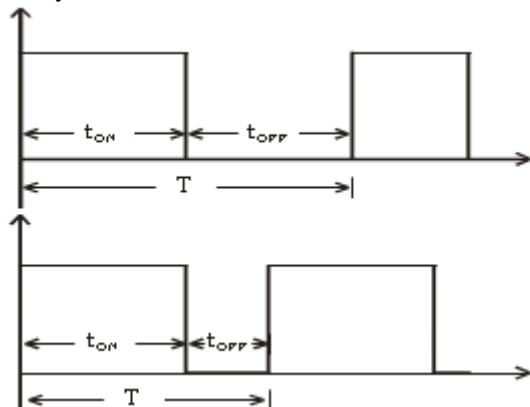


Figure 3.2: Variable frequency waveform

4. Voltage Commutated Chopper

Voltage Commutated choppers are widely used in high power circuits where load fluctuation is not large. This chopper is also known as

- 1) Parallel capacitor turn-off chopper
- 2) Impulse Commutated chopper
- 3) Classical chopper.

To start the circuit, capacitor ' C ' is initially charged with polarity (with plate ' a ' positive) by triggering the thyristor T_2 Capacitor ' C ' gets charged through V_s , C , T_2 and load.

As the charging current decays to zero thyristor T_2 will be turned off. With capacitor charged with plate ' a ' positive the circuit is ready for operation. Assume that the load current remains constant during the commutation process

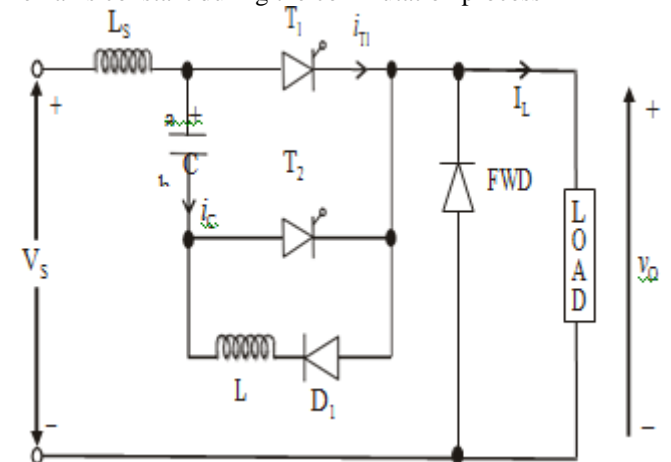


Figure 4.1: Circuit diagram of voltage commutated chopper

For convenience the chopper operation is divided into five modes:-

- 1) Mode-1
- 2) Mode-2
- 3) Mode-3
- 4) Mode-4
- 5) Mode-5

Choppers are classified as follows

- 1) Class A Chopper
- 2) Class B Chopper
- 3) Class C Chopper
- 4) Class D Chopper
- 5) Class E Chopper

5. Simulink Model & Result

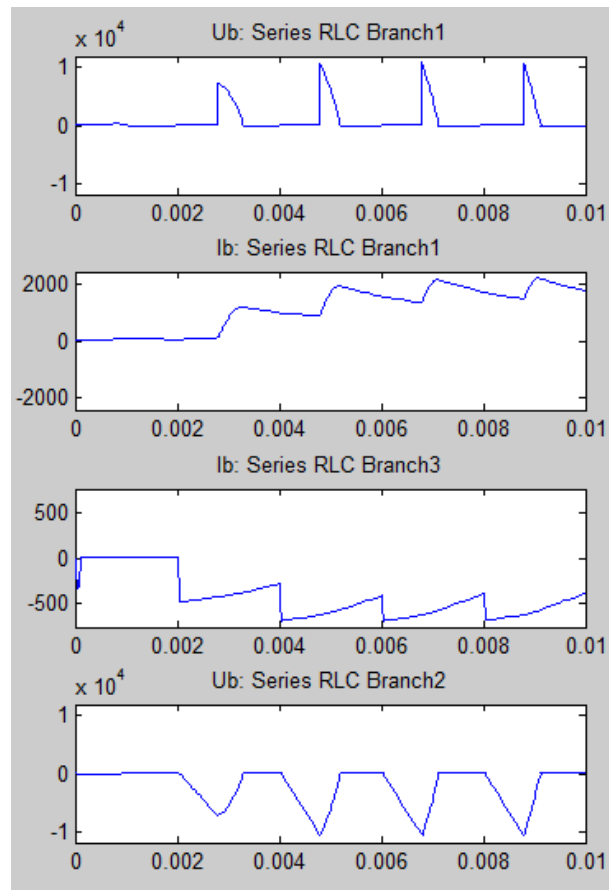


Figure 5.1: Output Waveform of Voltage commutated chopper

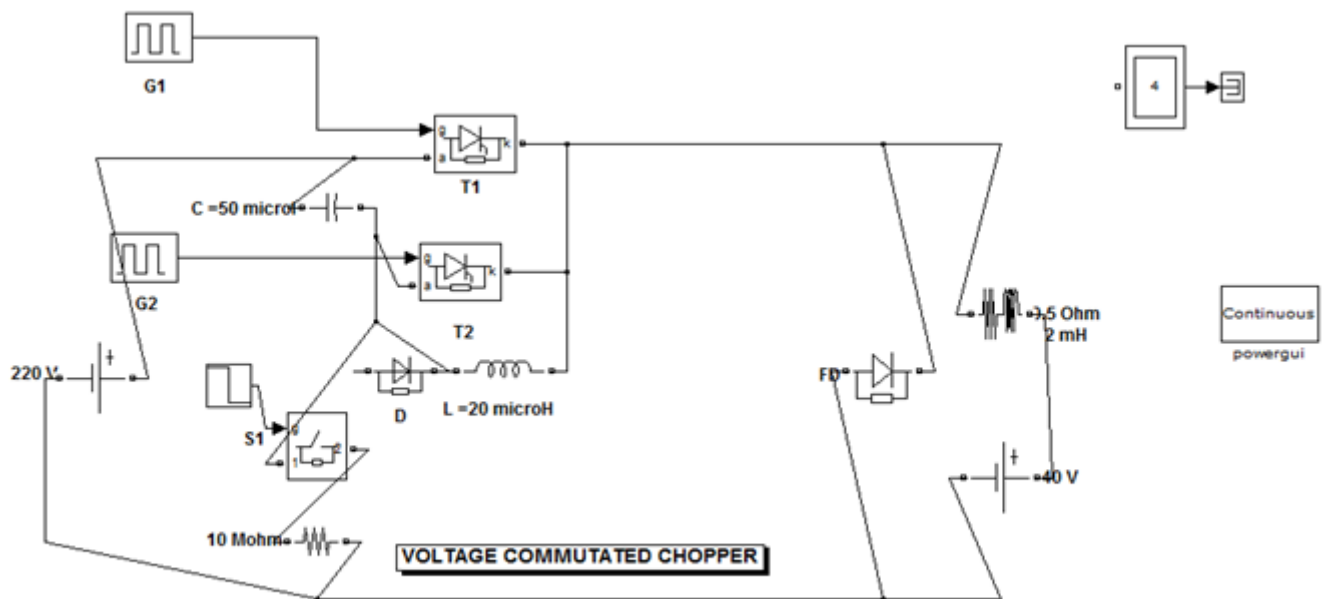


Figure 5.2: Simulink diagram of voltage commutated chopper

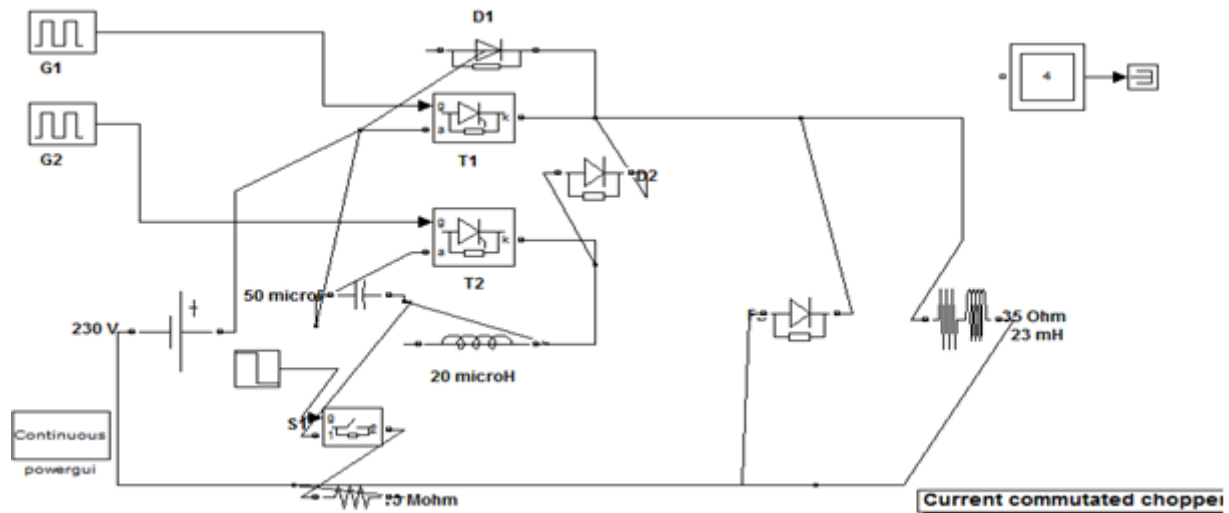


Figure 5.3: Simulink diagram of current commutated chopper

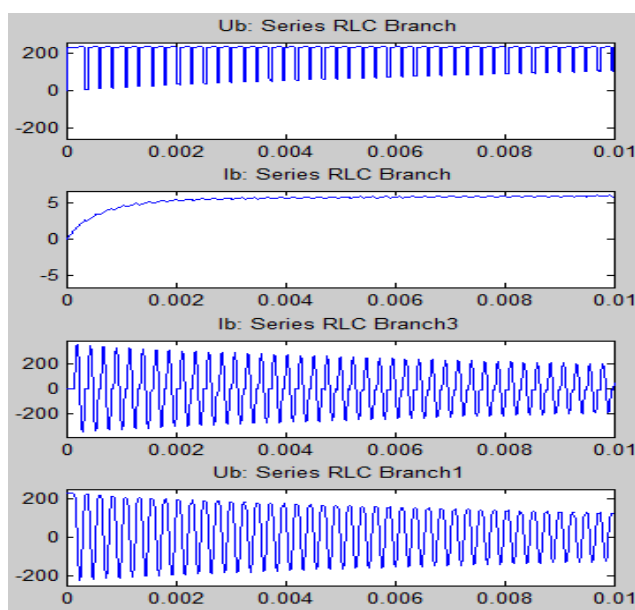


Figure 5.4: Output Waveform of current commutated chopper

6. Conclusion

In this paper we successfully study the simulation of Current Commutated Chopper and Voltage Commutated Chopper on Matlab. We also study the control strategies of Current & Voltage Commutated Chopper. The discharging and charging time of commutation capacitor are dependent on the load current and this limits high frequency operation, especially at low load current Chopper cannot be tested without connecting load.

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