Heaven's Light is Our Guide

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Lab Report 6: Study of Single Phase Bridge Inverter Using Simulink

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Study of Single Phase Bridge Inverter Using Simulink

Theory

The Single Phase Bridge Inverter is a power electronic circuit that converts DC input into AC output, enabling the operation of AC loads from a DC source. It is widely used in industrial applications for driving AC motors, renewable energy systems, and uninterruptible power supplies (UPS) [1].

Working Principle

The circuit consists of four switches (typically IGBTs or MOSFETs) arranged in an H-bridge configuration. By controlling the switching sequence, the polarity of the DC voltage applied to the load is alternated, generating an AC output. The output waveform can be controlled to approximate a sinusoidal waveform using techniques such as Pulse Width Modulation (PWM) [2].

Behavior with R Load

For a purely resistive load, the current waveform follows the voltage waveform. The output voltage is a controlled AC waveform, and the power delivered to the load is proportional to the RMS value of the output voltage. The switching pattern directly determines the quality of the output waveform [3].

Behavior with RL Load

For an inductive load, the current lags the voltage due to the inductance. This lag affects the switching transitions, as the current may continue to flow through the free-wheeling diodes even after the switches are turned off. The output voltage waveform is still controlled by the switching pattern, but the current waveform exhibits a phase lag [4].

Applications

- Speed control of AC motors
- Renewable energy systems (e.g., solar inverters)
- Uninterruptible Power Supplies (UPS)
- Industrial power regulation

The use of MATLAB/Simulink for simulation allows for detailed analysis of the inverter's behavior under different load conditions, enabling optimization for specific applications [5].

Required Equipments/Software

- MATLAB/Simulink
- DC Voltage Source
- IGBTs
- Capacitors
- Diodes
- Resistive Load (R)
- Inductive Load (RL)
- Pulse Generator for firing angle control
- Measurement Blocks (Voltage and Current)
- Scope for waveform visualization

Circuit Diagrams

Figure 1: Single Phase Full Bridge Inverter Circuit

Observations

- For the R load, the output voltage waveform is a controlled AC waveform, with the RMS value depending on the switching pattern of the inverter.
- Increasing the modulation index for the R load increases the effective RMS voltage and power delivered to the load.

- For the RL load, the output voltage waveform is controlled by the switching pattern, but the current waveform lags due to the inductance.
- The lagging current in the RL load causes the freewheeling diodes to conduct during the switching transitions.
- MATLAB/Simulink simulations show the impact of switching patterns on the output voltage and current waveforms for both R and RL loads.
- The circuit demonstrates effective conversion of DC to AC power, enabling operation of AC loads from a DC source.
- The behavior of the circuit under different load conditions highlights the importance of considering load characteristics in inverter design and operation.

Outputs

Figure 2: Simulation Output for R Load, Controlled Rectifier, No Delay

Figure 3: Simulation Output for RL Load, Controlled Rectifier, No Delay

Figure 4: Simulation Output for R Load, AC-AC Bidirectional Voltage Controller

Figure 5: Simulation Output for RL Load, AC-AC Bidirectional Voltage Controller

Discussion

The Single Phase Bridge Inverter is a crucial circuit for converting DC power to AC power, enabling the operation of AC loads from a DC source. Through MATLAB/Simulink simulations, we analyzed the behavior of the inverter under resistive (R) and inductive (RL) loads. The results demonstrate the impact of switching patterns on the output voltage and current waveforms. For R loads, the current waveform closely follows the voltage waveform, while for RL loads, the current lags the voltage due to inductance, affecting the conduction period of the freewheeling diodes.

Conclusion

The study of the Single Phase Bridge Inverter with R and RL loads highlights its effectiveness in converting DC to AC power and controlling the output waveform through switching patterns. The circuit's behavior under different load conditions underscores the importance of considering load characteristics in inverter design and operation. MATLAB/Simulink simulations provide valuable insights into the inverter's performance, enabling optimization for industrial applications such as motor drives, renewable energy systems, and uninterruptible power supplies.

References

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