University of North Carolina at Charlotte  
Department of Electrical and Computer Engineering

Junior Design Lab 2-1

**H-Bridge DC-to-AC Inverter**

Lab 2-0

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**Objective:**

The objective of this lab was to design, model, and simulate a H-bridge AC-to-DC Inverter using four MOSFETs, amongst other design parameters, to provide AC voltage over a load with less than 1% ripple and provide a current through the inductor with less than 10% ripple.

**Relevant Theory:**

The H-bridge DC-to-AC (DC/AC) inverter is composed of 4 MOSFETs, a PWM generator, and an output filter that transfers a given DC input voltage () to a load (. The voltage transferred is converted to an AC voltage output () that is 180 degrees out of phase with the input voltage.

In the United States, the standard frequency for AC voltage delivered to the household is 60 Hz which we determine as our output frequency (). This value is used later to calculate inductor () and capacitor () values in our DC/AC inverter circuit. To be a true inverter, our circuit must shift the phase of the input voltage by 180 degrees. To do this, the frequency of the second order filter must have a natural frequency () of . Natural frequency of the filter is given as:

**Design Parameters:**

* Power rating: 200W- 400W
* DC voltage supply (input): 30V-40V
* Switching frequency: 10kHz – 50kHz
* Duty Cycle: 70% - 85%.
* Current ripple in the inductor: less than 10% of the max current
* Output voltage ripple measured at the load: less than 1% at the max load

**Design Elements:**

* (4) MOSFETS
* 520 µH Inductor
* (2) 68 µF Capacitors
* 1.96 Ω Resistor
* DC Voltage Supply (Capable of 40V)
* PWM Generator
* Other elements needed to run the simulation (not essential in the converter operation)

**Schematic:**

A diagram of a circuit

Description automatically generated

**Questions:**

1. **Define your nominal operating conditions and specifications, i.e., switching frequency, input voltage, duty cycle, load resistance value, inductor and capacitor values, etc. Provide a justification on how to pick your inductor and capacitor values. Use standard values for capacitor values. I suggest using ceramic capacitors for filtering, voltage rating of about 100VAC. If you need a bigger capacitance for filtering, you can use Film capacitors.**

|  |  |
| --- | --- |
| **Design Specifications** | **Values** |
| Switching Frequency (*f)* | 10 kHz |
| DC Input Voltage (V­in) | 40 Volts |
| Duty Cycle (D) | 70% |
| Power Rating (P) | 400W |
| Load Resistance value (Ω) | 1.96 Ω |
| Inductor (H) | 520 µH |
| Capacitor (F) | 136 µF |

**Load Resistance:** We chose to achieve a power rating of 400 Watts so our system can handle the highest power rating in the design parameters.

Solving for and in the equation for , we get the following equations for the values of the inductor and capacitor in our circuit:

**Inductor:**

**Capacitor:**

1. **Provide the theoretical input-output voltage relationship. This is sometimes called conversion ratio. With your simulation, include a plot showing the input and output voltage. Does it follow the theoretical (calculated) value?**

**Load Voltage:** We chose a Duty Cycle of 70%, to account for low quality MOSFETS.

1. **At different instances (three or more), measure the current ripple in the inductor and voltage ripple across the output (capacitor) at your nominal operating point? With your simulation include a plot with your measurements.**

**Voltage Ripple:**

**Maximum Output Current:**

**Ripple Current:**

**Current Ripple: (Needs to stay between 12.857 A to 15.714 A) (10%)**

*A graph with a curve

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*A graph with a line on it

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**Voltage Ripple: (Needs to stay between 27.72 V to 28.28 V) (1%)**

*A graph with a line going up

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*A screenshot of a computer

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1. **Change the input voltage ±10V and run your simulation.**
   1. **In one plot, measure the output voltage, output current, and output power.**

*A screen shot of a graph

Description automatically generated*

* 1. **In another plot, show the inductor current and output voltage. Measure the inductor current ripple and output voltage ripple at different instances. Compare them with your nominal operating point.**

*[input plot]*

1. **Capture the input and output power by multiplying the respective current by voltage.**

**A graph with a curve

Description automatically generated**

**A screenshot of a computer

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1. **Measure the total harmonic distortion (THD) of the output current. Make sure it is less then 5%. If not, you need to change your filter values. You can use the FFT tools available in MATLAB/Simulink, simpscape library. You can use find the “FFT Analysis” under “Tools” tab in Powergui block. To use the FFT Analysis Tools, you need to log the data: open the Scope when you capture the measurements. Under “view”, Configuration Properties, Logging, check “Log data to workspace”. Assign a name for the “Variable name” and change the save format to “Structure With Time”. See below as an example**

**Conclusion:**

**Appendix:**

GitHub:[**https://github.com/RocketDan11/JuniorDesign**](https://github.com/RocketDan11/JuniorDesign)