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 an 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:**

One of the primary advantages of an H-bridge DC-to-AC (DC/AC) inverter is its ability to produce bipolar output voltages. This means it can switch between positive and negative voltage levels, allowing for a true AC waveform. The H-bridge is composed of 4 MOSFETs, a PWM generator, and an output filter that transfers a given DC input voltage () to a load (. The resultant AC voltage signal () in a true inverter will be 180° out of phase with the input voltage.

In the United States, the typical AC voltage frequency supplied to homes is 60 Hz, which we identify as our output frequency ￼￼) values in our DC/AC inverter circuit. A true inverter shifts the phase of the input voltage by 180 degrees. To accomplish this, the natural frequency () of the second-order LC filter should be . 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 () | 1.96 Ω |
| Inductor () | 520 µH |
| Capacitor (C) | 136 µF |

**Load Resistance:** To accommodate the maximum power rating specified in our design parameters, we opted for a power rating of 400 Watts for our system.

Solving for and in the equation for , we get the following equations for inductance and capacitance:

**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:** Toaccount for low quality MOSFETS, we chose a Duty Cycle of 70%.

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

Description automatically generated*

*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)