EE 452 – Power Electronics Design
Experiment 4 Procedure
Testing of Boost Converter

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1 Overview

The objective of this experiment is to build and fully test the power converter for a rated input of 24V and output of 48V.

2 Building the converter

Based on the analysis in your prelab and any additional discussion within your group, select the power transistor you would like to use to implement the Boost converter switches. Mount the power transistor on the heat-sinks from your lab kit. Use the (electrically isolating, thermally conducting) thermal interface material in your kit to insulate the transistor cases from the heatsinks. Construct the power stage as shown in Exp 3 on the perf board.

- Use lower gauge (16 AWG) wire to make interconnections in the power stage. Smaller cross- section wire can be used to make signal connections. Note: lower gauge means larger diameter.
- Aside from the previously mentioned locations, keep the wiring short for connections having pulsating currents.
- Insert gate resistors $R_{g_{on}}$ and $R_{g_{off}}$ between the driver outputs and the gates of the transistor to prevent excessive dv/dt at the switched node.
- Insert 10 $k\Omega$ resistors between gate and source $R_{gs}$of all power transistors to ensure that, when not driven, the devices default to cutoff operation.
- **(Optional):** Place the current sensor and auxiliary circuit in series with your inductor so that you measure i_L.
- **Overvoltage protection:** Based on your Lab 2A, limit the converter output voltage to 55V.

3 Testing the converter

Add the TVS diode (1.5KE75A) and MOV (V100ZA15P) to the output of your boost converter.These are protection devices meant to ensure that the bus voltage is never allowed

to rise above 75 V. Per operation constraints, this voltage should never go above 55 V during proper operation. Before you begin any power conversion, answer the following questions

- Is the load connected? In an unloaded asynchronous boost converter, the output voltage will increase unbounded. Does this matter if you operate your synchronous boost converter? Why/Why not?(**5 pts**).
- Make a table of the power stage components and experimental conditions. This should include the inductor, power MOSFETS, input and voltage levels, corresponding load levels and expected currents(**5 pts**).

Pick the maximum value of load resistance to get minimum power level from the power converter. Make sure to turn on your power supply at a low voltage level (preferably 5V) and increase the voltage in steps. The gate driver will kick on beyond 12V at its input, which means the supply has to be pushed upto 24V. Adjust the PWM input to get an output voltage of 48V. **Remember that the LO output of the gate driver is the COMPLEMENT of the PWM input**. Before the gate driver kicks on the supply will get connected to the load through the body diode of the top MOSFET drawing a current depending on connected load value. **Warning: resistors may get hot.**

For your report, you will need to collect the following:

- **Gate Driver Outputs:** Now that you have MOSFETs to drive, you can see the HO and bootstrap capacitor voltage of your gate driver.

  Capture 1: HO and LO of gate driver. User cursors to find the deadtime and compare with deadtime given in the datasheet. **(10pts)**

  Capture 2: (EE452 optional) Voltage waveform across bootstrap capacitance. This is a floating voltage, so make sure only 1 probe is connected to the oscilloscope. **(10 pts)**

- Take a photograph of your setup and annotate the image by labeling the each module: drive circuit, power stage, auxiliary power supply, etc.(**15 pts**).
- Following the same startup procedure explained in the previous paragraph, record the following waveforms/quantities for 4 different power levels (different load resistances) **(Vin=24V, Vout=48V).**
  - Scaled inductor current (if the current sensor used), otherwise input current drawn from power supply. **(+10pts EC for using current sensor and doing conversion calculations)**
  - Boost converter output voltage (waveform)
  - Switch node voltage (Voltage across bottom MOSFET) (waveform)
  - Input voltage from power supply

    In case you are unable to capture a specified waveform, explain what you think the error is and what could be the solution to the problem. This increases your chances of getting credit for this section.(**80 pts**)

- **Duty sweep:** For one load level vary the duty cycle of the boost converter, note down the output voltage levels and draw up a graph of the measured efficiencies with voltage level. Do not exceed 55V (**40 pts**)
- **Efficiency sweep:** Compute the efficiency at four load stages and draw up a graph of the measured efficiencies with power level. (**25 pts**)