Lab 2: Power converters (Part 1 - Synchronous buck converter)

A buck converter is an efficient way to step down DC voltages. The efficiency comes from the use of pulse width modulation, ensuring the switching elements are either fully on or off which minimises their power dissipation. During this lab we will design a basic buck converter and look at its efficiency and switching waveforms.

Equipment

- Diode
- MOSFETS
- Inductor
- Capacitors
- Gate driver (IR21834PBF)
- 100Ω load (20W) WARNING: THIS WILL GET HOT
- Deadtime resistor

Deliverables

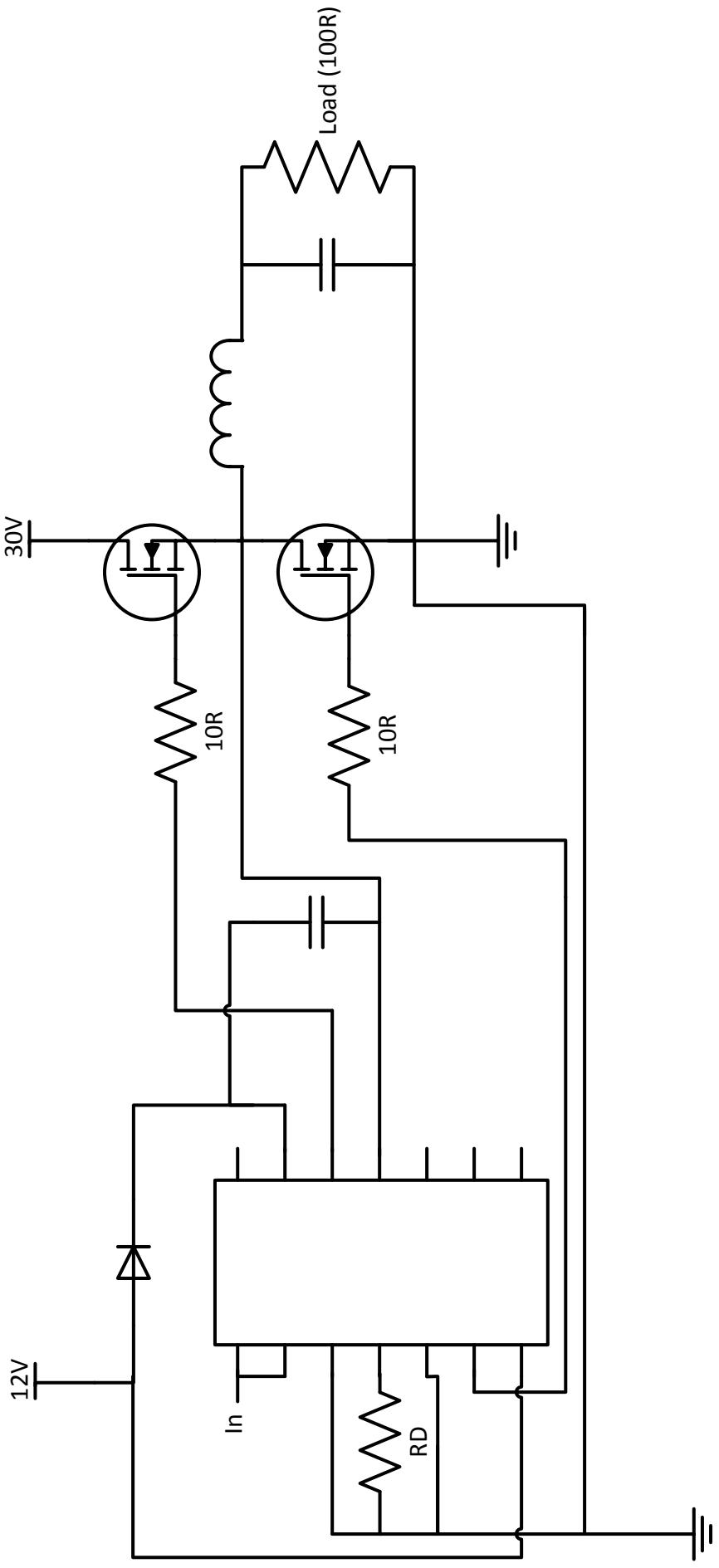
1. Design a continuous conduction mode buck converter output filter, to meet the specs shown below.
2. With the buck converter designed above in (1), calculate the frequency at which the buck converter will go in to discontinuous conduction mode.
3. Use the gate driver datasheet to calculate the value of a deadtime resistor that will give approximately a 0.5 microsecond deadtime.
4. Describe deadtime and its function
5. How could we keep the output constant with a varying input voltage?
6. Oscilloscope screen showing the waveform on the drain of the MOSFET. Give a brief description of the waveform.
7. Create a graph showing the efficiency vs output current of the converter. Comment on where the main losses are.
8. Describe the function of a bootstrap circuit.

Methodology

Assemble the schematic shown in the gate driver datasheet (bootstrap cap = 0.47uF, decoupling caps =10uF) on breadboard. Add the benchtop multimeter in series between the 30V supply and the MOSFET in current sense mode. Connect the signal generator on ?pulse? mode, at a frequency of 22kHz, to the gate driver. Set the duty cycle to 10%, the Vpp to 5V and the offset to 2.5V. Attach a probe to the gate of the MOSFET and switch on the signal generator to ensure the gate driver is creating the PWM. Increase the duty cycle to 30% and probe the source of the MOSFET to complete deliverable 2. Next attach the probe across the load, and measure the output voltage ignoring the output ripple. Note down the input current and output voltage for duty cycles 10% to 80% in increments of 5%. From here you should be able to calculate the input and output power to complete deliverable number 3.

Table 1: Buck converter specs

Input voltage	30V
Output voltage	20V
Output power	4W
Switching frequency	22kHz
Inductor current ripple	40%
Output voltage overshoot	5%


Load (100R)
30V
10R
10R
12V
In
RD