

Lab 3

Switching regulators

In this lab you will build and characterize a step-down (buck) switching regulator based on the LM3578 regulator chip.

Pre-lab

1. Read the data sheet carefully, and in particular understand the recipe for selecting components.
2. Do step 1.
3. Do step 2.
4. Devise the experiment in step 4.

Design and build the switching regulator

1. Given that the data sheet says the duty cycle of the switch can be up to 90% (90% closed), what does that say about the ratio of input and output voltages in a step-up regulator?
2. Explain how the circuit in Figure 15 of the LM3578 works, and the purpose of the different components.
3. Using the recipe in the data sheet, design a step-down regulator that produces 10 V output from a 15 V input. Choose the switching frequency such that the regulator operates in continuous mode down to a load current $I_O = 50$ mA, and such that the inductor value is not more than a few mH, and such that the frequency is between 1 kHz and 100 kHz.

Characterize the switching regulator

4. Devise an experiment for measuring the efficiency of the regulator (amount of power dissipated in the load divided by power input to the regulator).
5. For a load current larger than the minimum continuous operation load current (for example 100 mA) measure the output voltage and ripple, the switching frequency and duty cycle, and plot the voltage across the inductor (using math mode on the scope) and the diode over several periods. Vary the input voltage over some reasonable range and describe what happens. How much larger must the input voltage be than the output voltage for proper operation? Also measure the efficiency (for 15 V input only) using the method you devised in step 4.

6. Repeat the previous step for a load current smaller than the minimum continuous operation load current (for example 10 mA).
7. Discuss and explain the measurements you see in the previous two steps. In particular, connect the voltage measurements across the diode and the inductor, as well as the duty cycle to the theory of operation of switching regulators.