The University of Stellenbosch

Electronics 414

Practical 2

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1. Please bring a small screwdriver and a soldering iron with you to the practical.
2. The practical takes place in the electrical machines laboratory. According to the rules of this laboratory every student has to wear shoes that completely cover their feet and pants that reach down to the knees.
3. Everyone has to complete their preparation before the practical. Students who have not completed their preparation would not be allowed to enter the laboratory.
4. Every group has to demonstrate the operation of their circuit to the lecturer. Make sure that your name is marked off before leaving the laboratory.

Specifications

This practical is the first step in the design of a half-bridge power supply. The specifications of the power supply are as follows:

Input voltage	V_d	30 V
Output voltage	V_o	15 V
Duty cycle	D	$\frac{1}{3}$
Load current	I_o	1 A
Switching frequency	f_s	50 kHz
Filter inductance	L	2 mH
Filter capacitance	C	1 000 μF

The following components will be used in this practical:

- 2 x ETD32/16/9 E-cores.
- Coil former and clamp.
- Copper wire with a cross-section of 0,9 mm.
- 2 x BYV29 diodes mounted on a small piece of aluminium.

- MOSFET half-bridge.
- LC low-pass filter.

Preparation

1. Study the data sheets of the components listed above.
2. Calculate the number of primary turns of the transformer. According to Ampères law

$$v_1 = N_1 A_e \frac{dB}{dt},$$

   where N_1 is the number of primary turns, A_e is the effective core area and B the flux density. Draw the waveforms of voltage v_1 across the primary of the transformer as well as the flux density B. Use these waveforms to calculate the number of primary turns if the maximum flux density is 200 mT. (Hint: The average value of the flux density calculated over a switching cycle is 0 T.)
3. Calculate the number of secondary turns.
4. Assume that all the components are ideal and make detail drawings of the following waveforms:
   (a) The voltage across the filter inductor.
   (b) The current through the filter inductor.
   (c) The current through the primary and secondary windings of the transformer.
   (d) The current through each of the switches.
   (e) The voltage across each of the switches.
   (f) The current through each of the diodes.
   (g) The voltage across each of the diodes.
5. Calculate the rms-values of the current through the primary and secondary transformer windings and determine the minimum cross-section of the copper wire. Design for a current density of 10 A per mm^2.
6. Make an estimation of the total length of wire that is required to wind the transformer.
7. Calculate the average conduction losses in each of the switches and diodes.

Practical

1. Connect the two PWM outputs of the pulse width modulator to the PWM inputs of the gate driver and connect the gate driver to the MOSFET half-bridge. Make sure that the half-bridge switches and measure the switching frequency. (Remember to connect a 12 V source to the pulse width modulator and gate driver.)

2. Wind the transformer and connect it to the half-bridge. Measure the voltage on the secondary side of the transformer and make sure that the winding ratio corresponds to its theoretical value.

3. Connect the diode rectifier and filter to the circuit and test the circuit with and input voltage of 30 V.

4. Draw a graph of the output voltage as a function of load resistance. Take care not to exceed the maximum load current of 1 A.

Demonstrate the operation of the circuit to the lecturer before leaving the laboratory.