The University of Stellenbosch

Electronics 414

Practical 1

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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 is required to wear pants that reaches their knees and shoes that completely cover their feet.
3. All students have to complete their preparation before the practical. Students who have not completed their preparation would not be allowed to enter the laboratory.
4. Every student has to write his or her own report. For this practical the results may be filled in on this guide.
5. Every group must demonstrate the operation of their circuit. Also make sure that your name is marked off before leaving the laboratory.

Preparation

This practical is about the step-down converter. An IGBT phase-arm (half-bridge) is used to construct the step-down converter. A block diagram of the phase-arm is attached to this guide. Only the upper IGBT is switched, while the diode of the lower IGBT is used as a free-wheeling diode.
The step-down converter operates at a DC bus voltage V_d of 30 V and a switching frequency f_s of 5 kHz. The filter inductor L has a value of 2 mH.

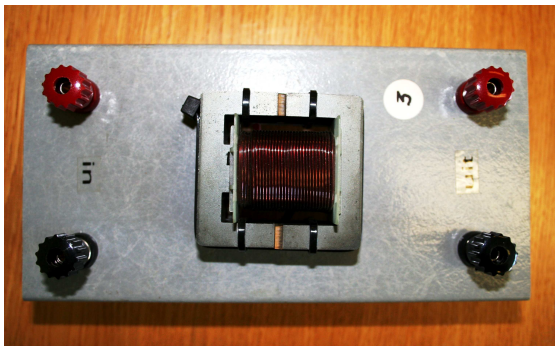
1. Draw waveforms of the inductor voltage v_L and inductor current i_L for a duty cycle D of 0,5 and a load resistance R of 30 Ω.
2. Calculate the output voltage V_o for a duty cycle of 0,3.
3. Study the block diagram of the phase-arm and output filter and make sure that you know how to connect them to form a step-down converter.

4. Study the characteristic curve of the LEM current sensor and make sure that you know how to convert its output voltage to an equivalent current.

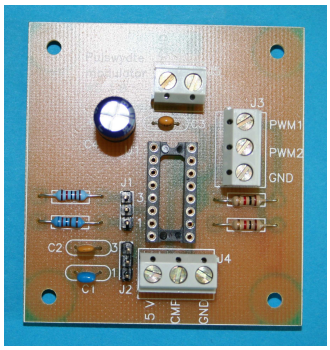
Practical

Equipment: 1 IGBT phase-arm, 1 Output filter, 1 Pulse width modulator, 1 Multi meter, 1 hundred Ω adjustable resistor, 1 two channel power supply.

Phase-arm



Output filter

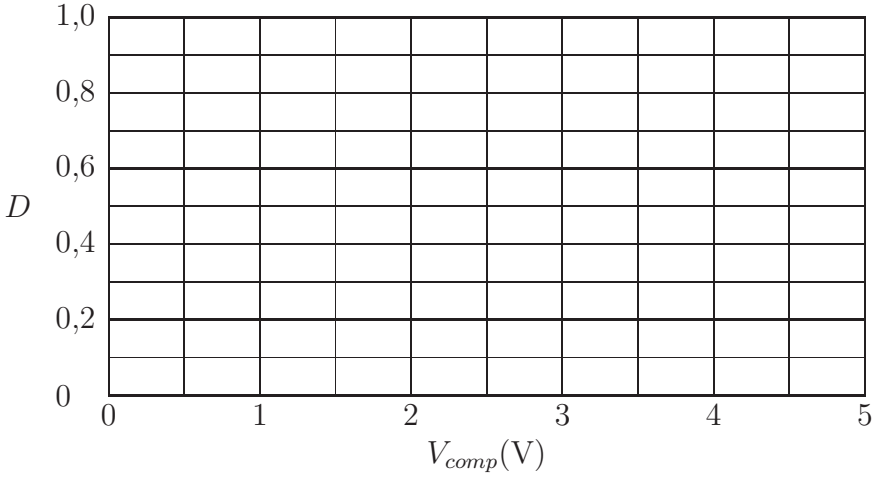


Pulse width modulator

Set one channel of the power supply to 12 V and connect it to the 12V input of the pulse width modulator as well as the 12 V input of the gate driver of the phase-arm. **This voltage may never exceed 12 V.** Connect the PWM1 and PWM2 outputs of the pulse width modulator to one another and to the TOP input of the phase-arm‘s gate driver.

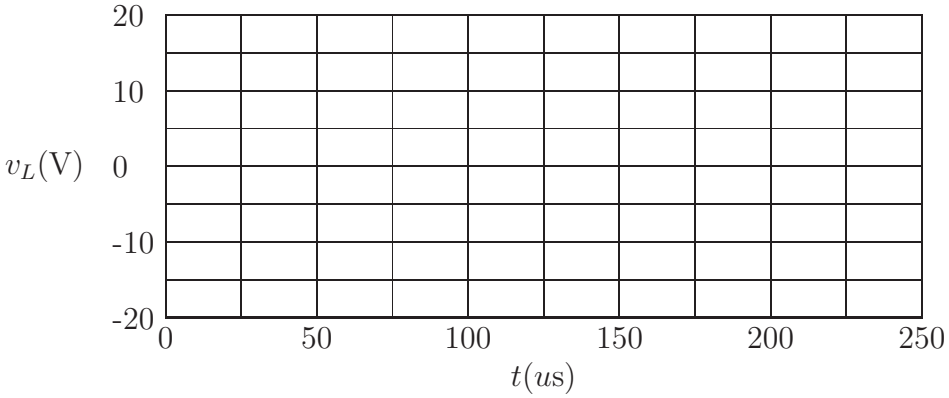
1. Measure the switching frequency f_s of the pulse width modulator. $f_s =$ Hz

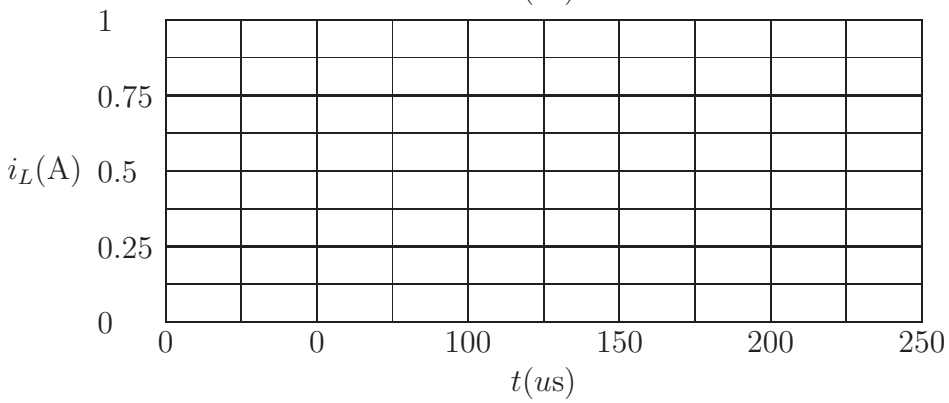
2. Measure the value of the duty cycle of the pulse width modulator as a function of the voltage at the CMP pin (pin 9) of the pulse width modulator. Draw the result on the graph below:



Connect the phase-arm, filter and load resistor and set the input voltage V_d of the step-down converter to 30 V. Use the second channel of the power supply as a 30 V source.

3. Set the load resistor to 30 Ω and the duty cycle D to 0,5. Measure the waveforms of the inductor voltage v_L and the inductor current i_L. Draw the results on the graphs below. **Hint:** Measure the DC-component of the inductor current with a current meter and the AC component with the LEM current sensor.





How does this compare with your theoretical waveforms?

4. Measure the efficieny η (power out divided by power in) of the step-down converter.

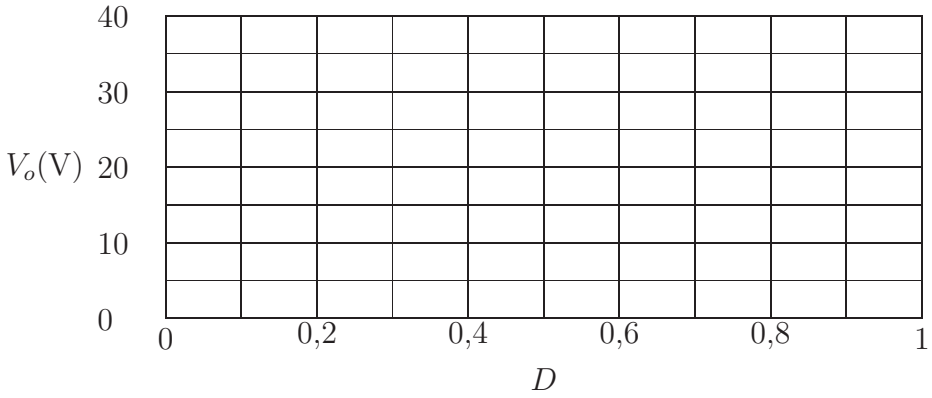
$I_d =$ (A) $I_o =$ (A)

$V_d =$ (V) $V_o =$ (V)

$P_d =$ (W) $P_o =$ (W)

$\eta = \frac{P_o}{P_d} =$ (%)

5. Measure the output voltage V_o as 'n function of the duty cyle D. Draw the result on the graph below.



Comment on this:

6. Set the duty cycle to 0,3 and measure the output voltage V_o as a function of the load resistance R. Tabulate the values in the table below.

$R(\Omega)$	V_o(V)
∞	
100	
80	
50	
30	

What is the theoretical value of V_o? $V_o =$ V

Comment on this:

7. Set the load resistance to 50 Ω and show the waveforms of i_L and v_L on the oscilloscope. Try to explain what you measure.