Lab 1

Exercise:

If you have followed the prestudy you should at least have checked the resistance for the Vin already.

1. Start with connecting power and measure the voltage out from your regulators with no load, what are the voltages? What ripple do you get from booth the outputs? You can use Vp-p or rms value to compare with.

4 µs ≈ 260 kHz 4 µs No freq.

12,0V / 7,6V pk-pk 5,11V / 5,5V pk-pk

2. How does it compare with specifications?

RMS voltages are good, freq good

3. Load the output to half specified output current, do the same measurements. What ripple do you get now from the two regulators?

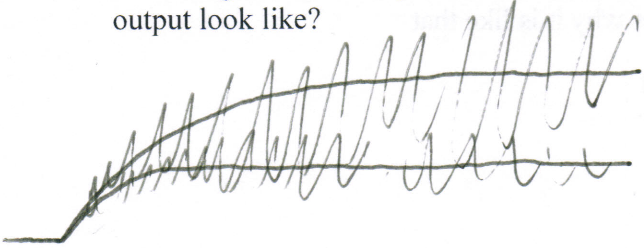
4 µs ≈ 500 kHz PWM syns

11,93V / 29,13V pk-pk 5,05V / 13,1 pk-pk

4. What is the lowest input voltage the LM2673 works at (where it still keep the output level).

13,2V => +1,2V ≈ FB voltage

5. Measure the input and output of the LM2673 during the input is switched on. See how the voltage rises. Here you need to use "single shot" for the measurement. How does the output look like?



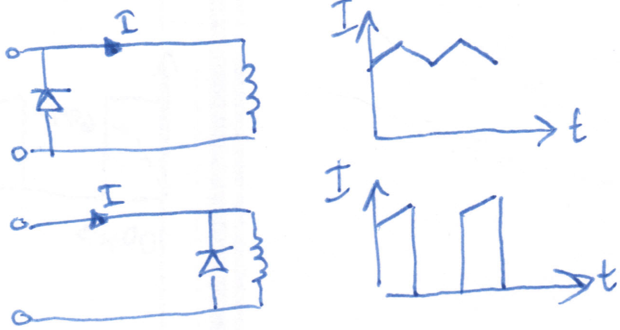
6. Now, measure the input and output ripple for LM2673 at full load, what attenuation do you get? Give the answer in dB. This will not be done totally exact, but anyway...

Amplified ripple, ≈ 6dB

7. What temperature of the case do you get, when using the regulators at max power? What is the theoretical temperature from your design? Is the difference big?

$\theta_{JC} = 2$

$\theta_{JA} \approx 65\ ^{\circ}C/W$ $T = T_A + P(\theta_{JC} + \theta_{CA})$ Går ej!



Lab 2 Control of inductive load.

Aim of lab:

After this lab you should be able to take care about problems that will occur with PWM control of inductive load. You should aswell understand how you can connect motor drivers to your microcontroller.

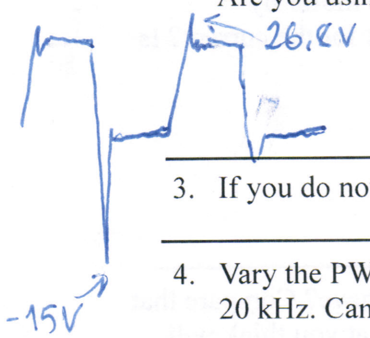
Exercise:

1. Start with picking up a coil and measure the resistance and inductance. Measure with and without iron core. Use the core in the following experiments.

Same res.
Without core: 29,7 mH   With core: 37,5 mH

2. Connect a coil to your transistor. Control it with a 50% duty cycle and 6 kHz frequency. This will preferably be done from the mbed controller. Measure, with oscilloscope, the voltage V_{DS} over the transistor. How does the voltage look like and what levels do you get? Are you using a diode or not?

6kHz



Diode

3. If you do not have a diode put one in parallel with the coil.   Yes

4. Vary the PWM dutycycle, use two different switching frequencies, approximately 20 Hz and 20 kHz. Can you get different forces from the core? Why are you getting it or not?

20Hz weak, 20kHz strong

5. Use 50% dutycycle, change direction of the connection to the coil so the current will have the opposite direction trough the coil. What can you notice? You should have a plunger inside the coil.

Nothing happens, coil changes polarity

6. If you place the diode at coil or at the board, what differences would that give you? What could the differences be for radiated emissions?

Best is on coil, otherwise cable becomes an antenna.

7. Change to your motordriver circuit. Connect your PWM signal to the Phase pin. Connect the enable and mode pin appropriate. Use 20 kHz as switch frequency. What value have you chosen as current limiter?

0,4 Ohm

10 kHz   Pass. 5k 6nF

Lab 3 Filtering technique

Objectives:

After this exercise you should be able to build analogue antialiazing filters and implement digital filters on a microcontroller. You should also get knowledge about design and analysis of different kind of filters.

N.B

Always check the input voltage to the microcontroller A/D. It should be between 0-3,3 V. No more no less!

Exercise:

1.Start with your passive lowpass filter.
What sampling frequency f_s are you using and what cutoff frequency f_c have chosen?

f_s = 10 kHz , f_c = 5 kHz

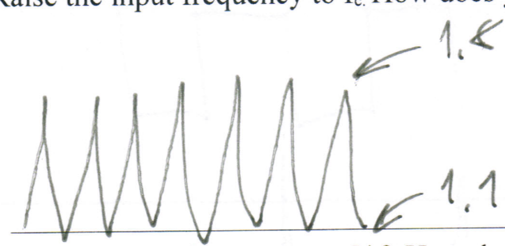
2.Test the filter itself with a frequency generator. Put sinusoidal signals into the filter. Measure (as you learned in Lab1) with oscilloscope before and after the filter. What cutoff frequency can you measure? How is that compared to your theoretical f_c ?

$f_{c\,real}$ = 6,5 kHz => 23% error

3.Connect your filter to the controller N.B. Be aware of the signal level so you don't break the A/D converter! and put a sinusoidal signal with $f_c/5$ into the filter. Send the data to the PC and plot your signal in matlab. What can you see? What amplitude do you measure compared to the function generator output?

≈ The same

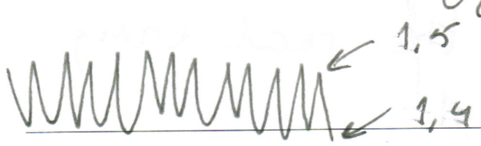
4.Raise the input frequency to f_c. How does your sampled signal look now?



≈ Same amplitude

5.Raise the input frequency to 5*f_c. How does your sampled signal look now?

0,225 V in



Min. 0.37
Max. -0.36

Lab 4 Current sensor.

Exercise:

1. Start with calibrating your sensor. Let a known current go through your sensor and a known resistor as load. Measure the voltage drop over the load (you could use a current meter instead or read the current output from a power supply) with a multimeter you trust and compare that with your sensor output. Get at least three measurements max positive/negative current and zero. Is your sensor linear? What noise level could you see at for example zero and max current.

0,1 A →

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2. Connect the sensor to the motor, feed the motor with dc voltage. Put a load on the other motor by adjusting the load potentiometer to some value. Measure the current from your sensor with an oscilloscope. How does the signal look like? Try with some different currents. Try with the measuring resistance both over and under the motor.

-0,28A → 0,88 V　　0,28A → 2,6V
-0,01A → 1,68 V　　0,02A → 1,8V
-0,1A → 1,47

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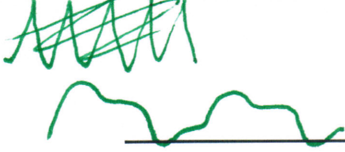
3. Now use a PWM from your µ-controller to control the motor via your motor driver from lab3. Measure the current with an oscilloscope. How does it look? Measure the noise level. Use some different currents. At constant PWM signal you will be able to measure the SNR, Signal to Noise Ratio, SNR= $(A_{sig}/A_{noise})^2$ or in dB SNR=20*$\log_{10}(A_{sig}/A_{noise})$. AC couple the oscilloscope to get the noise rms value, the average current is equal to the amplitude (DC level) of the signal.
What SNR value do you get?



$SNR_{0,05}$ = 8　　$SNR_{0,33}$ = 1,36
$SNR_{0,064}$ = 100　　$SNR_{0,1}$ = 6,25

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4. Connect a lowpass filter to your sensor output. Is the signal looking better? What SNR are you getting now?

$SNR_{0,05}$ = 47
$SNR_{0,33}$ = 9

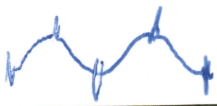
Lab 5. Integration.

Aim of lab:

This lab is mainly about connecting your modules from prior labs to one system. Have the right supply voltage to the motor, with respect to the power supply for the INA126.

Exercise:

1. When connecting everything together and give 50% dutycycle to the motor, do you get any change in current signal, level or noise compare with lab 4?



2. Use your predesigned current controller in the Mbed code. Can you control the current in both directions?

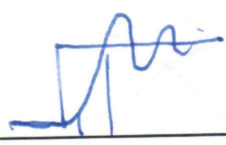
Yes

3. Put a constant I_{ref} as an input to your current controller (could be done both internally or external). How big is the steady state error?

A little, < 1%

4. Try with a square wave signal as I_{ref}, how long time constant do you get?

1 ms



5. Connect a sinusoidal signal as I_{ref}. At what frequency do you get -3dB amplification for the real current?

360Hz

6. Can you think of any way to raise the bandwidth of your controller?

Reduce response lag,

7. Disturb your controller by varying the load, is the current still constant?

Yes

Ready!