ECEN 5053-001

Lab 6:

DC Brush Motor Linear Speed Control

10-26-17

Goal: Control the speed of a running dc brush motor in a linear manner using feedback from current ripple.

Equipment and Parts Required: Cypress PSoC CY8CKIT-050B development board, power supply, digital oscilloscope, dc brush motor with encoder and gearbox (Pololu item 2822, supplied), fast recovery power diode.

Step 1- (FET and motor speed threshold test)

Apply a sawtooth waveform to the FET gate and observe the motor current. The sawtooth period should be long enough to allow the motor to begin to turn as the voltage passes the FET threshold. You decide how fast or slow this needs to be.

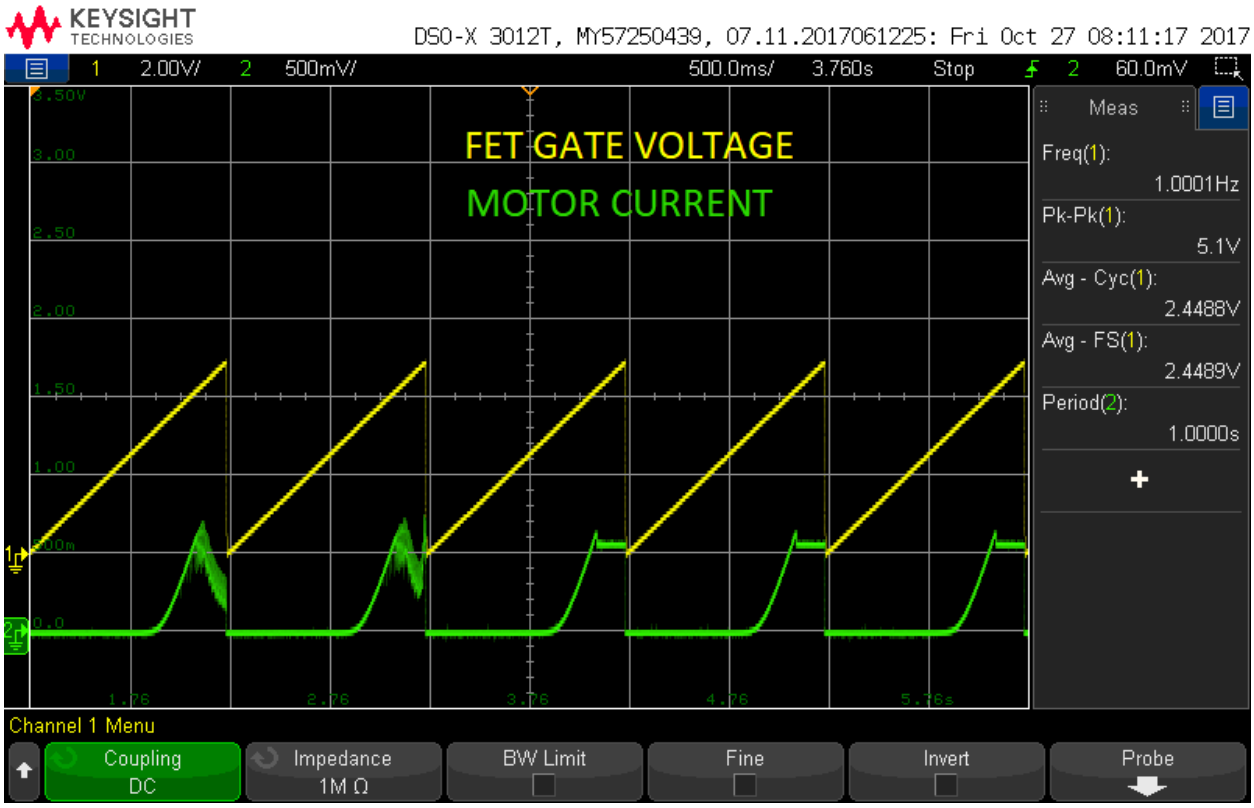
Question 1: At what voltage does the FET begin to turn on?

Answer: 3.1V

Question 2: At what voltage does the motor begin to turn?

Answer: 3.7V

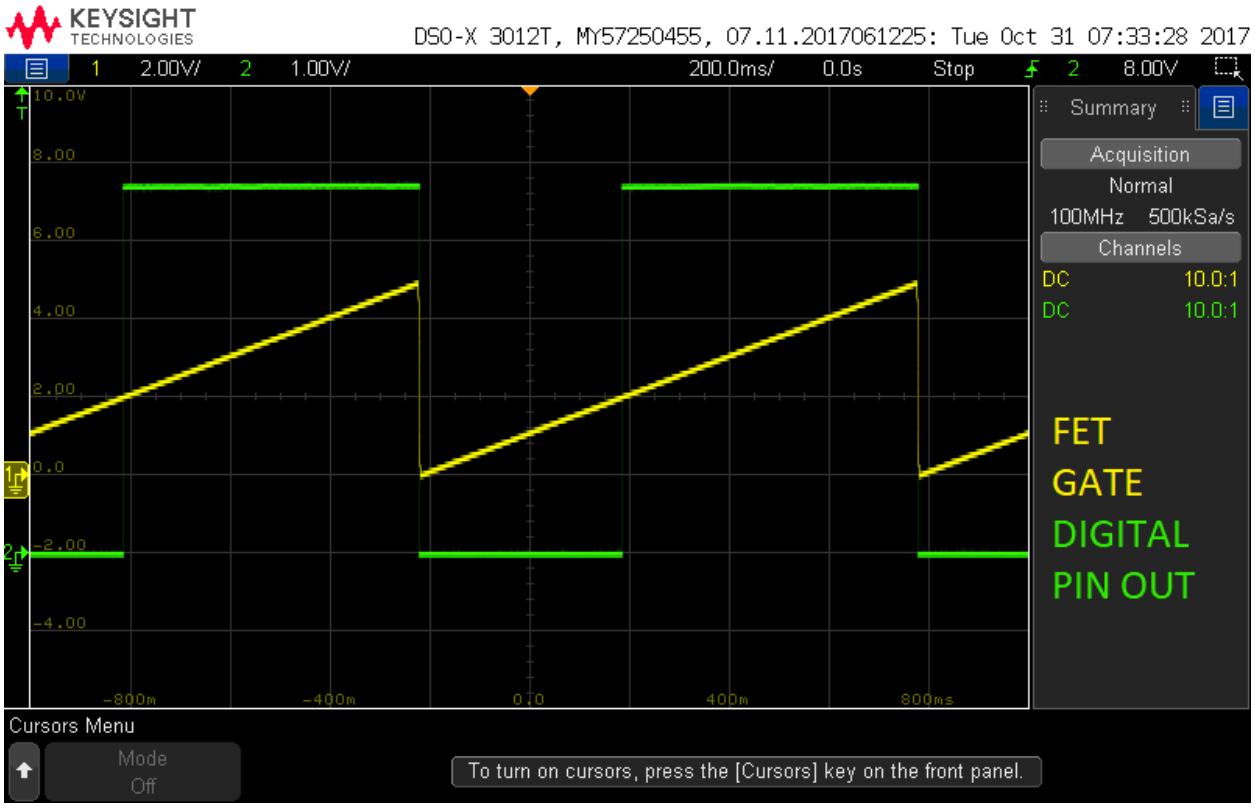
Scope shot 1: ch 1 = FET gate voltage, ch 2= motor current (note scale in mA/volt). Show 4 cycles of the saw tooth. Allow the motor to turn freely for the first two cycles, then hold the shaft still for the last two cycles to see the difference. Note on the trace when the motor begins to turn.

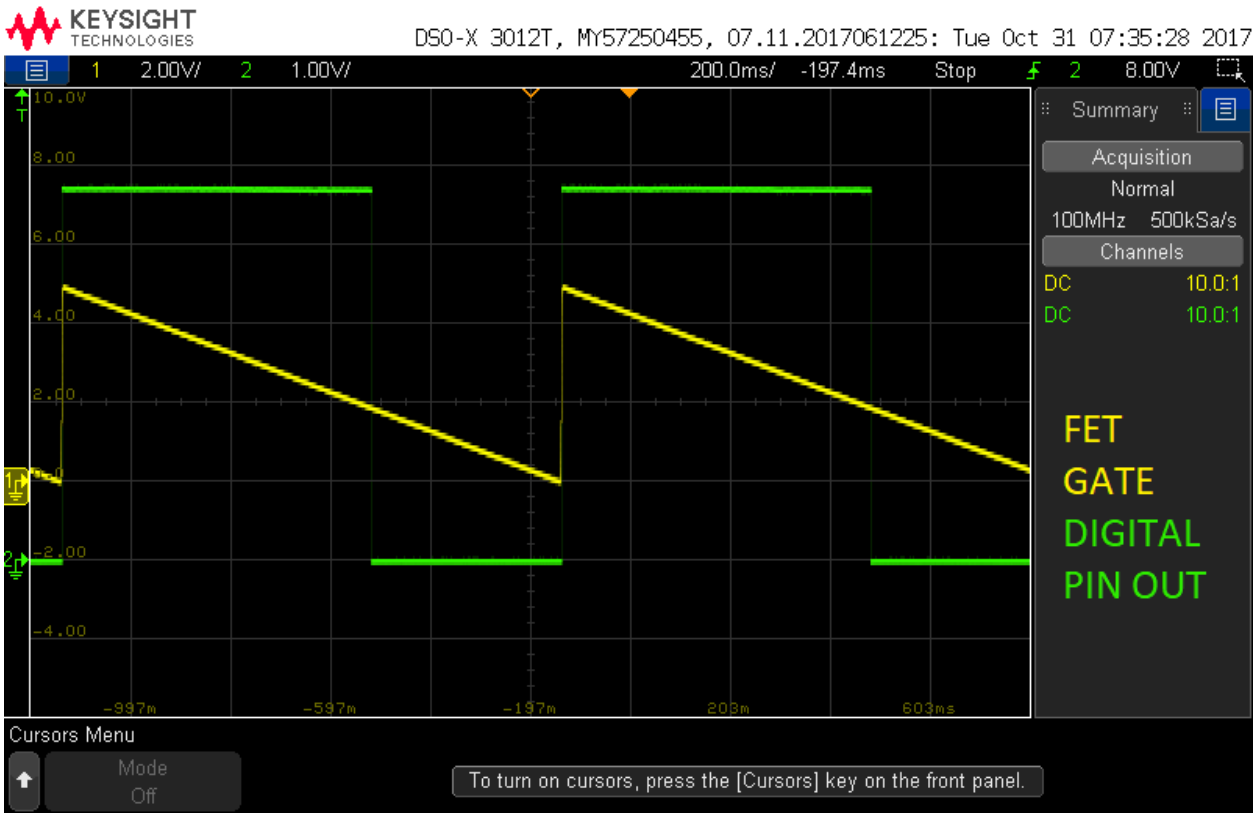


Step 1A: PSOC Pin Threshold Test:

Apply a similar slow saw tooth waveform to a digital input PSOC GPIO pin, filp an output pin high when the pin reads high and vice versa.

Scope Shot 1A: Ch1: Sawtooth Waveform. Ch2: Pin output.


KEYSIGHT TECHNOLOGIES
DSO-X 3012T, MY57250455, 07.11.2017061225: Tue Oct 31 07:33:28 2017
1 2.00V/ 2 1.00V/ 200.0ms/ 0.0s Stop 2 8.00V
Summary
Acquisition
Normal
100MHz 500kSa/s
Channels
DC 10.0:1
DC 10.0:1
FET
GATE
DIGITAL
PIN OUT
Cursors Menu
Mode
Off
To turn on cursors, press the [Cursors] key on the front panel.


KEYSIGHT TECHNOLOGIES
DSO-X 3012T, MY57250455, 07.11.2017061225: Tue Oct 31 07:35:28 2017
1 2.00V/ 2 1.00V/ 200.0ms/ -197.4ms Stop 2 8.00V
Summary
Acquisition
Normal
100MHz 500kSa/s
Channels
DC 10.0:1
DC 10.0:1
FET
GATE
DIGITAL
PIN OUT
Cursors Menu
Mode
Off
To turn on cursors, press the [Cursors] key on the front panel.

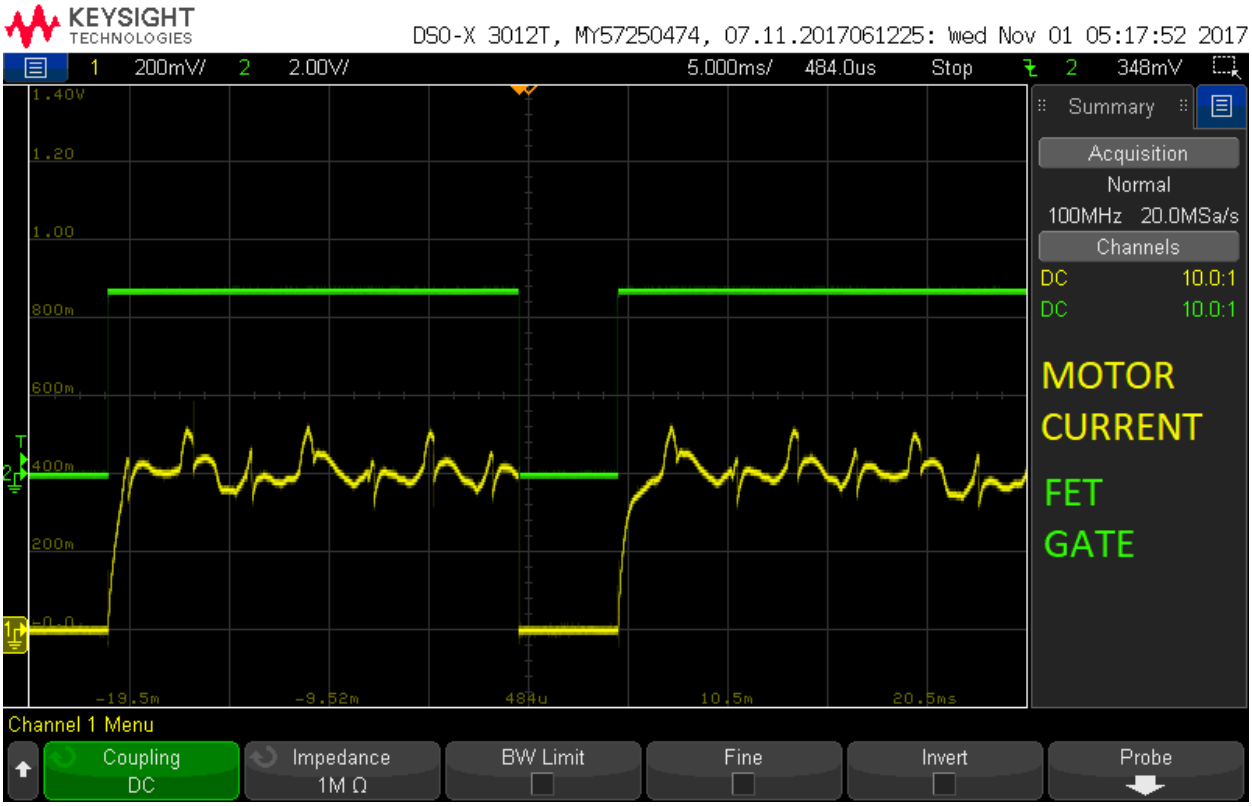
Question 1A: Explain what is going on?

Answer: The PSOC Reads the digital input pin as '1' if it's voltage is above 2V and reads it as '0' if the voltage is below 2V.

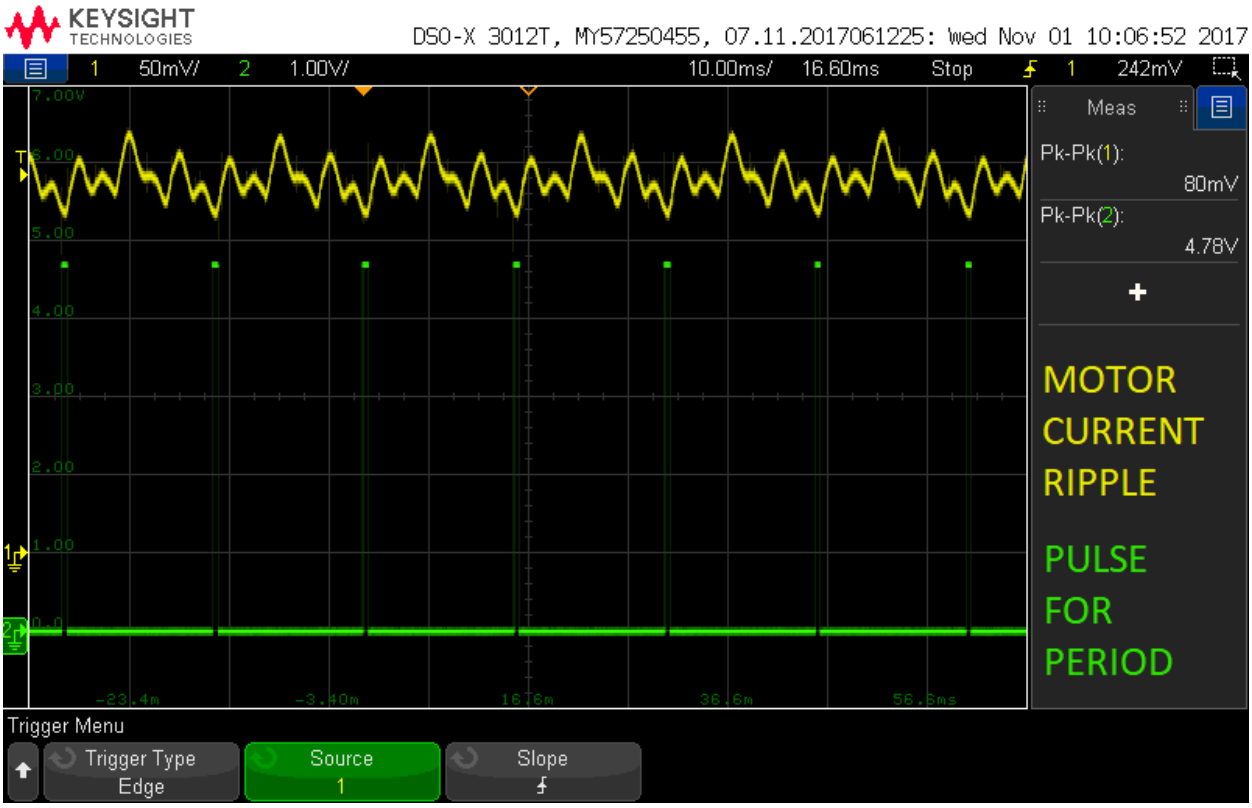
Step 2- (look at current ripple)

Allow the motor to turn freely at a fixed speed of your choice. (Apply a variable (by potentiometer) fixed dc voltage to the gate of the FET, do not PWM it) Observe the motor current with your oscilloscope.

Scope Shot 2: Ch1: FET Gate Voltage, ch 2 = motor current (note the scale in amps/volt)



Extra Credit (+1 points): Using some method, determine the period of the current ripple in software. Demonstrate that this works by outputting a GPIO pulse in sync with the current ripple.

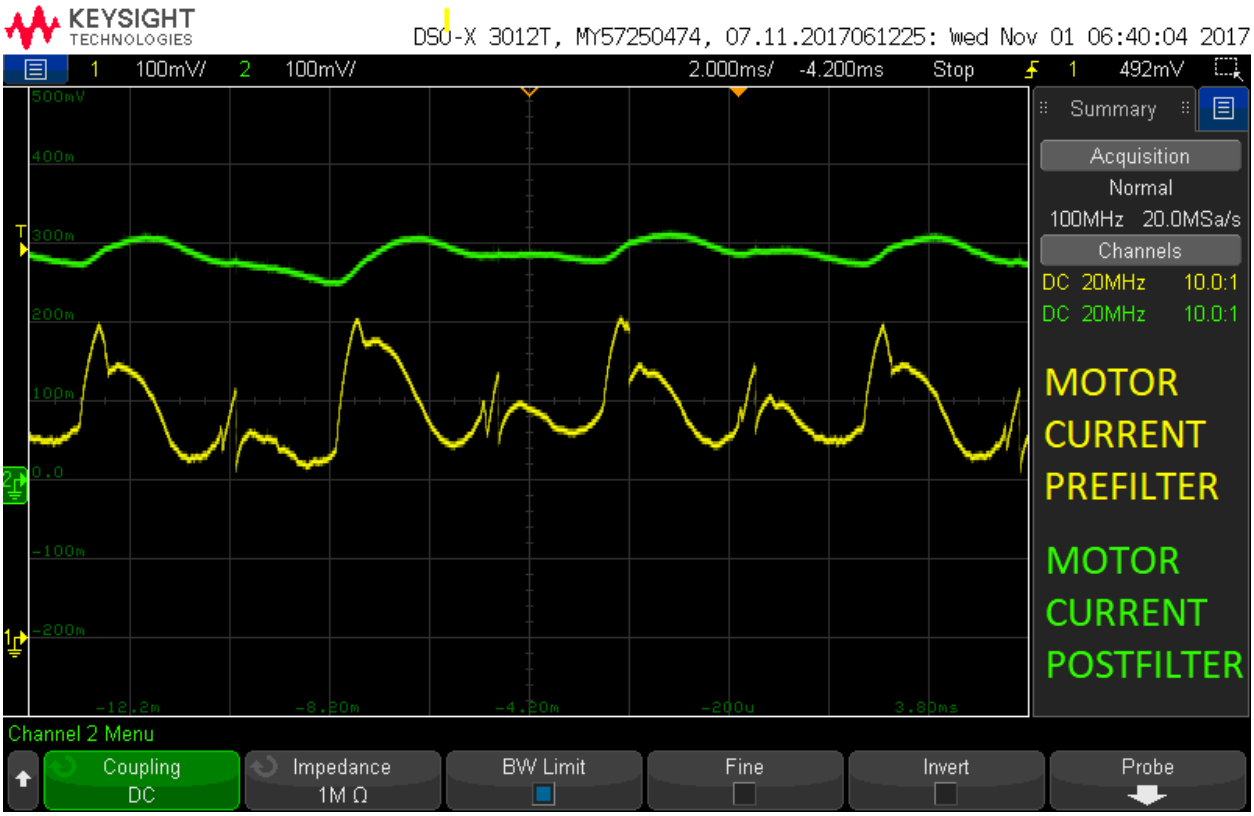


Step 3: Filter the Motor Current:

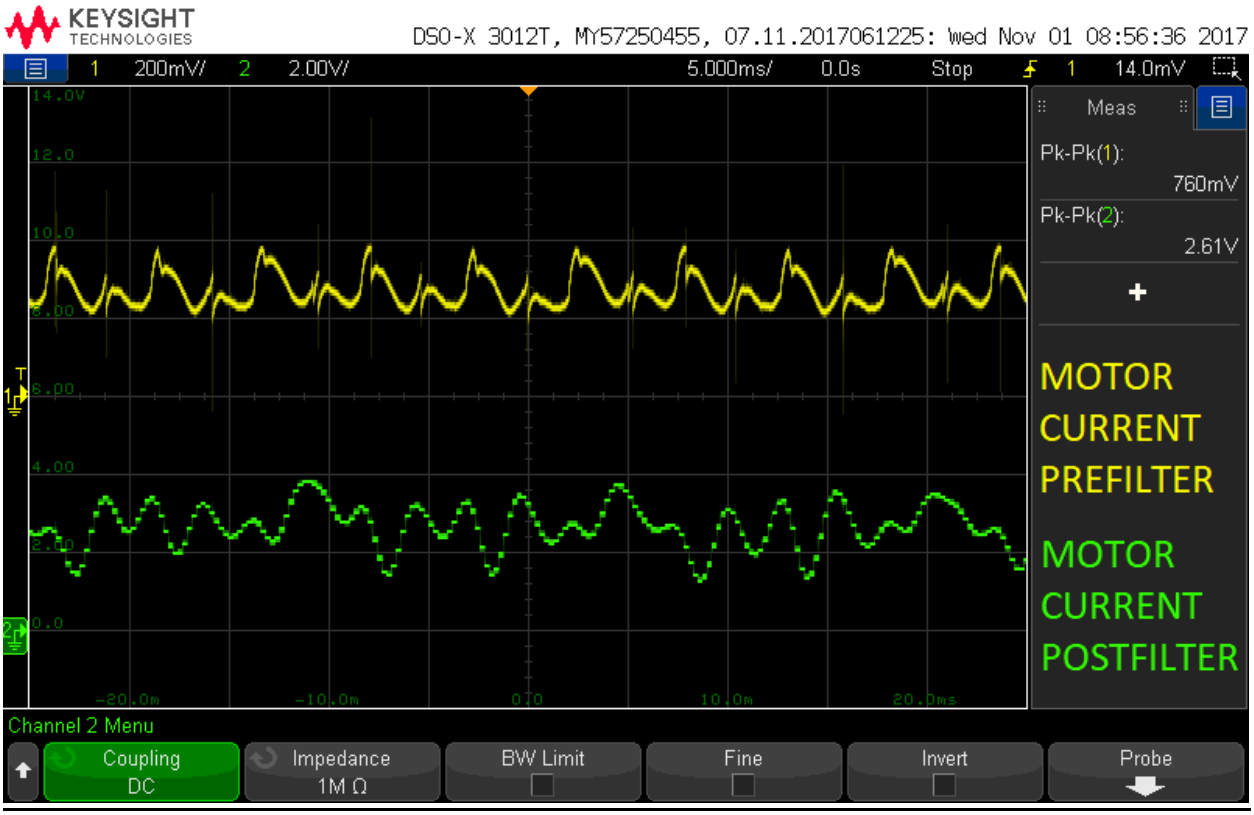
Build a passive analog circuit that filters the commutation spikes and other general noise.

Scope Shot 3: ch 1 = motor current (pre filter) ch 2 = motor current (post filter).

Build a digital filter (in software) that filters the commutation spikes and other general noise.



Scope Shot 4: ch 1 = motor current (pre filter) ch 2 = motor current (post filter).

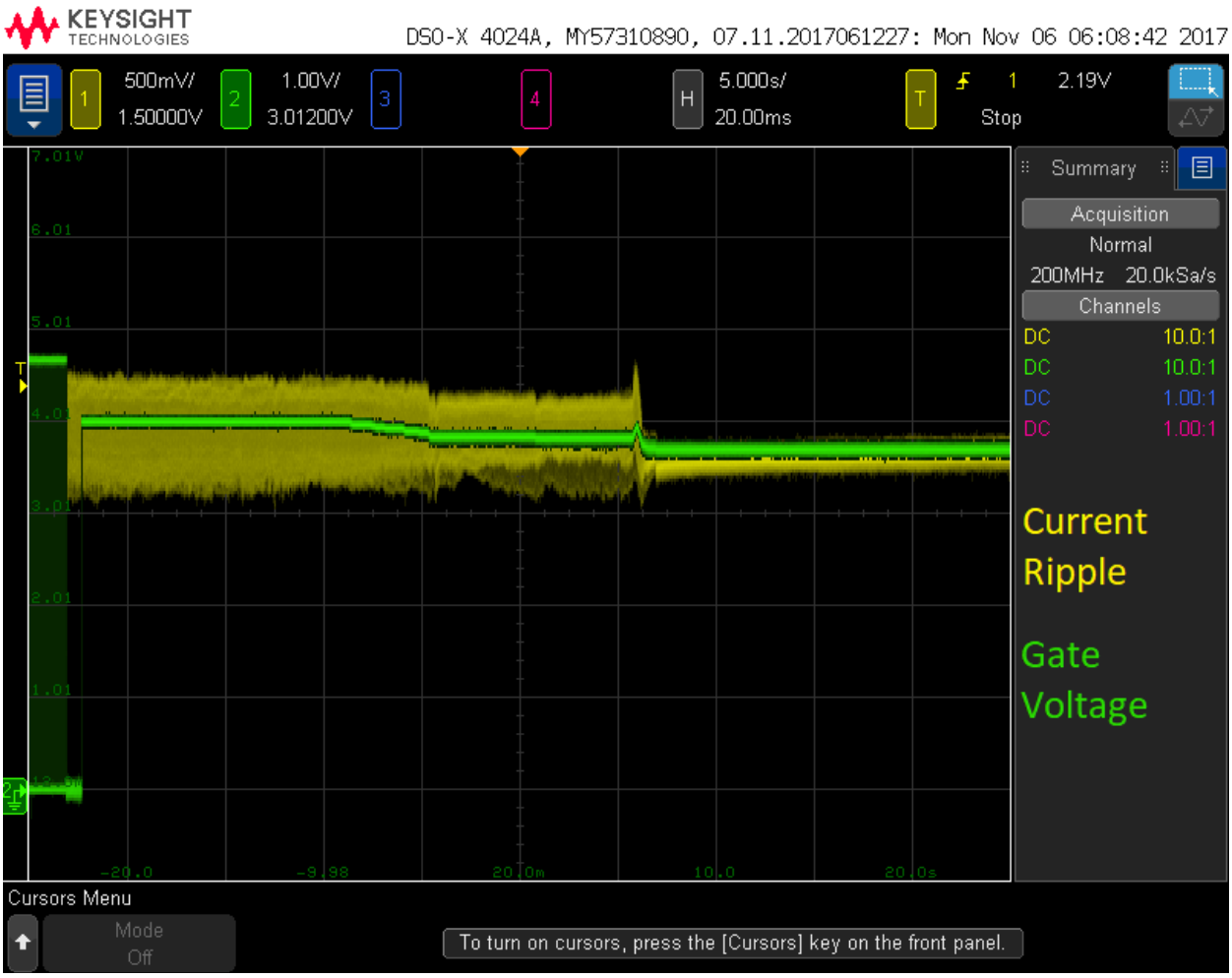


Step 4- (closed loop speed control)

Question 3: How much power is being dissipated in the FET at each of the two speeds?

Answer: Vds is 60mv. Average Current is 235mA. So the powere dissipated is 14.1 mW.

Scope shot 5: ch 1 = motor current (note scale in mA/volt) as the motor changes from one speed to the next, ch 2= FET gate voltage. Use a relatively slow scope sweep rate.



Scope shot 6: Move the motor at a constant steady state speed, then add drag from your finger to show the effect- the FET gate voltage should increase while the speed only changes a little. ch 1 = motor current (note scale in mA/volt) as the motor turns at a steady speed, ch 2 = FET gate voltage

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