ECE 2201 – LAB 4B

MOSFET SWITCHING APPLICATIONS

Introduction to Pulse Width Modulation (PWM)
A Motor Speed Controller

PURPOSE:

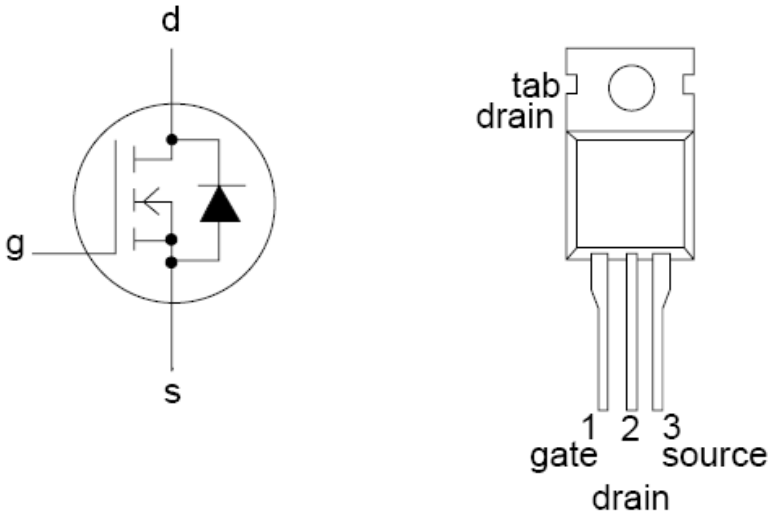
The purpose of this laboratory assignment is to investigate the basic operation of a Pulse-Width-Modulated (PWM) Motor Speed Controller using an N-channel power MOSFET.

Upon completion of this lab you should be able to:

- Understand the basic operation of a PWM motor speed controller.
- Adjust the duty cycle of a PWM control signal from 5-95%.
- Display appropriate waveforms on an oscilloscope.

MATERIALS:

- ECE Lab Kit
- DC Power Supply
- DMM
- Function Generator
- Oscilloscope
- IRF520 or IRF530 power N-Channel MOSFET
- DC MOTOR



PRELAB

P1. Read over the lab. SIMULATE the circuit of Fig. 4-1B using Multisim and vary the duty cycle of the control signal from 5 to 95%. Record the waveforms at the gate of the MOSFET (node 1), as well as the voltage at the drain terminal (node 2). Provide simulations for 25%, 50% and 75% duty cycle.

BACKGROUND

The circuit of Fig. 4-1B shows an IRF520 N-channel power MOSFET used to control the speed of a DC motor. The gate of the MOSFET is being driven by a pulse-width-modulated (PWM) signal to minimize power losses in the circuit.

The duty cycle (% ON-time) of the control signal determines the average DC voltage applied to the motor, thus controlling its speed. Since the MOSFET switch has a low resistance when on (ideally 0Ω) and a high resistance when off (ideally infinite), very little power is dissipated in the MOSFET during normal operation.

The diode in the circuit is used as a "free-wheeling diode" to provide a path for the induced motor current to flow, when the MOSFET turns off. Without this diode, a high voltage spike would occur across the MOSFET during turn-off and would damage or destroy the MOSFET.

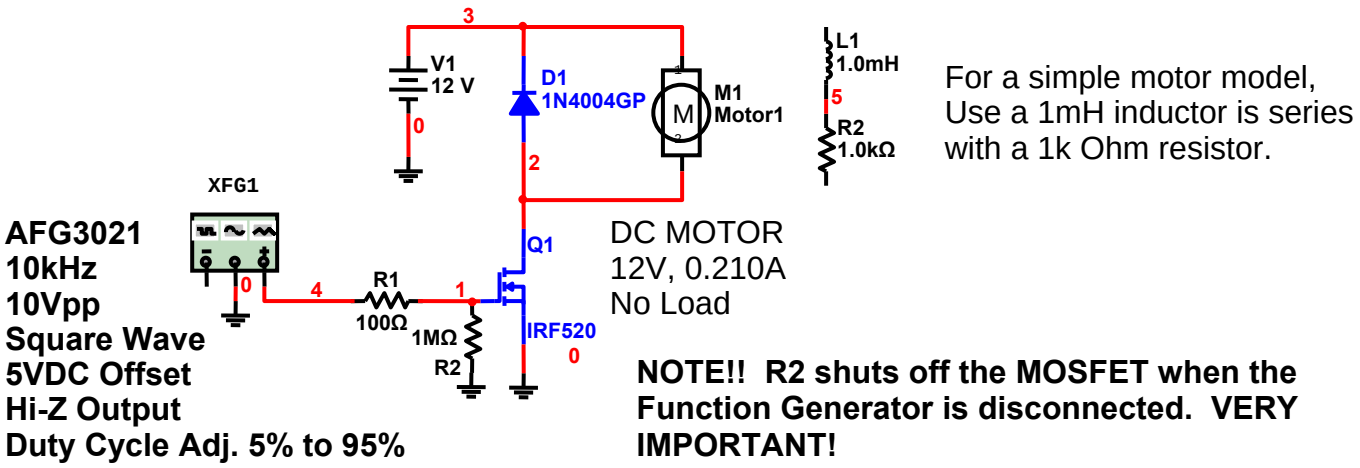


Figure 4-1B.

LAB PROCEDURE

Function Generator Set-Up

L2. Set up the function generator to provide a 10Vpp square-wave with a DC offset of 5V and a frequency of 10kHz. Set the output of the generator to HI-Z so that its output voltage levels match the settings on the screen.

NOTE: If you are getting twice the amplitude than you expect, it is because you are not operating in HI-Z mode.

IMPORTANT: Check the control signal for proper voltage levels using an oscilloscope BEFORE connecting it to the MOSFET! It should be a 0 to 10 Volt square-wave signal.

PWM Signal

L3. Verify that you can adjust the duty-cycle of the control signal from 5 to 95%. The duty cycle refers to the percentage of time that a square-wave signal is high. Set the duty cycle to 50% before proceeding to the next step in the lab.

L4. Build the circuit of Fig. 4-1B. Connect the function generator to the MOSFET and verify that the motor is spinning. Vary the duty cycle from 5 to 90 percent and confirm that the motor speed varies in proportion to it.

ALSO, be sure to connect resistor R2 which discharges the MOSFET gate-source capacitance if the function generator is disconnected. Otherwise, the motor might not turn off and the MOSFET will overheat.

L5. Connect two channels of the oscilloscope to monitor the voltages on the Gate and Drain of the MOSFET. Record waveforms for 25%, 50% and 75% duty cycle.

WRITE-UP

W1. Provide a comparison of simulated and measured waveforms for the PWM motor speed controller.