AE6705 Lab 2
Code Composer Studio

Yunqing (JJ) Jia

September 10, 2024

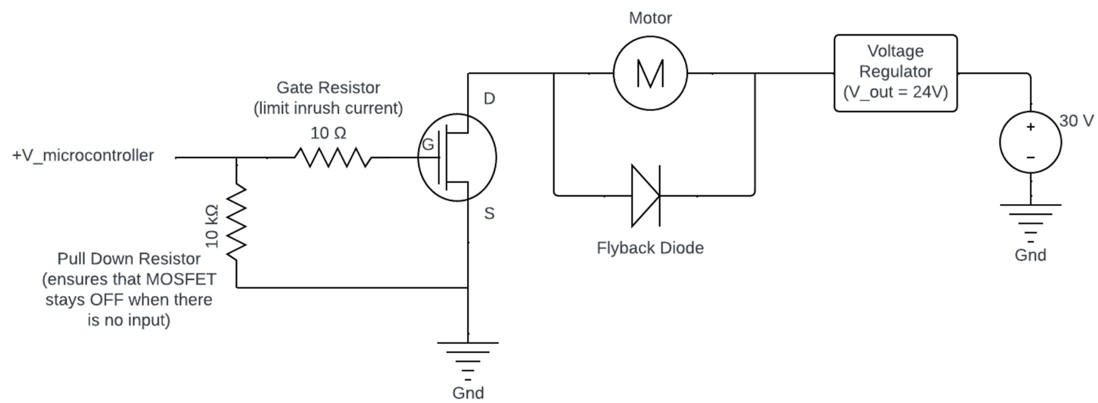
1. *(Debugging)* In the variables window, right click on the Value property of cm. Change the Number Format to hexadecimal. What is the value shown? Confirm that this value is equal to the decimal value displayed (show your work).

   `cm = 1000 (default decimal) = 0x000003E8 (hex)`
   `0x000003E8` $= 8 \times 16^0 + 14 \times 16^1 + 3 \times 16^2 = 8 + 224 + 768 = 1000$

2. *(Debugging)* Now press F8 four more times (or click on the Resume button four more times), letting the program stop at line 36 before each time you press it. Monitor the value of counter in the Expressions window. What is the value of counter after you have pressed F8 four times? After changing the displayed format to binary, how many bits are shown? Why is this number of bits displayed (recall data types)?

   In the code, `cm` is set to `counter * 1000`, resuming 4 more times increments the counter by 4.
   `cm = 5000 (default decimal) = 00000000000000000001001110001000b (binary)`
   32 bits are shown because `cm` is declared as type `int`, which has the size 4 bytes or 32 bits

3. *(Circuit Design)* Design a circuit that uses a solid state (semiconductor) device to switch a DC motor ON or OFF. The circuit should be able to handle high current spikes. The voltage source available is a 30VDC power supply. The motor specifications are given in the "DC motor.pdf" file (use the second motor requiring rated 24VDC supply). Notice the starting current of the motor is a high value. (Hint: Consider using a transistor-based switching circuit such as that shown in Slide 38 of Lecture 2, with appropriate modifications as desired.)



4. *(Circuit Design)* Find a solid state (semiconductor) switching device on the internet that can be used in the above circuit. Attach the datasheet for this device. Point out to the important details in the datasheet of the device that proves the usability of the device.

Table 1: Motor Specs

Operating Voltage (V)	10.8 to 26.4
Rated Voltage (V)	24.0
No Load Current (mA)	35
Rated Load Current (mA)	159
Starting Current (mA)	815

NTE2980 (N channel MOSFET) can be used as the switching device. The specs pdf is attached to the end of this report.

- Max. drain current: $I_D = 7.7A$ at room temperature, well above the maximum current the motor might draw when starting up, 815 mA
- Drain-Source Breakdown Voltage: $V_{DSS} = 60V$. If the voltage between the drain and the source exceeded this during the OFF state, current will start to flow. This is selected to be well above the operating voltage of the motor to ensure that there would be no current flowing in the OFF state.
- Gate threshold voltage: $V_{GS(th)} = 1 - 2V$. This switch can be turned ON/OFF using our microcontroller.

ELECTRONICS, INC.
44 FARRAND STREET
BLOOMFIELD, NJ 07003
(973) 748-5089
http://www.nteinc.com

NTE2980
Logic Level MOSFET
N-Channel, Enhancement Mode
High Speed Switch
TO251

Features:
- Dynamic dv/dt Rating
- Logic Level Gate Drive
- R_{DS}(on) Specified at V_{GS} = 4V & 5V
- Fast Switching
- TO251 Type Package

Absolute Maximum Ratings:

Drain Current, I_D	
Continuous (V_{GS} = 5V)	
T_C = +25°C	7.7A
T_C = +100°C	4.9A
Pulsed (Note 1)	31A
Total Power Dissipation (T_C = +25°C), P_D	25W
Derate Above 25°C	0.20W/°C
Total Power Dissipation (PC Board Mount, T_C = +25°C, Note 2), P_D	2.5W
Derate Above 25°C	0.02W/°C
Gate-Source Voltage, V_{GS}	±10V
Single Pulsed Avalanche Energy (Note 3), E_{AS}	47mJ
Peak Diode Recovery dv/dt (Note 4), dv/dt	4.5V/ns
Operating Junction Temperature Range, T_J	–55° to +150°C
Storage Temperature Range, T_{stg}	–55° to +150°C
Maximum Lead Temperature (During Soldering, 1.6mm from case, 10sec), T_L	+260°C
Maximum Thermal Resistance:	
Junction-to-Case, R_{thJC}	5.0°C/W
Junction-to-Ambient (PCB Mount, Note 2), R_{thJA}	50°C/W
Junction-to-Ambient, R_{thJA}	110°C/W

Note 1. Repetitive Rating: Pulse width limited by maximum junction temperature.
Note 2. When mounted on a 1" square PCB (FR-4 or G-10 material).
Note 3. L = 924μH, V_{DD} = 25V, R_G = 25Ω, Starting T_J = +25°C, I_{AS} = 7.7A.
Note 4. I_{SD} ≤ 10A, di/dt ≤ 90A/μs, V_{DD} ≤ $V_{(BR)DSS}$, T_J ≤ +150°C.

Rev. 8-10

Electrical Characteristics: (T_J = +25°C unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Drain–Source Breakdown Voltage	BV_{DSS}	V_{GS} = 0V, I_D = 250μA	60	–	–	V
Breakdown Voltage Temperature Coefficient	$\Delta V_{(BR)DSS}/\Delta T_J$	Reference to +25°C, I_D = 1mA	–	0.073	–	V/°C
Static Drain–Source ON Resistance	$R_{DS(on)}$	V_{GS} = 5V, I_D = 4.6A, Note 5	–	–	0.20	Ω
		V_{GS} = 4V, I_D = 3.9A, Note 4	–	–	0.28	Ω
Gate Threshold Voltage	$V_{GS(th)}$	V_{DS} = V_{GS}, I_D = 250μA	1.0	–	2.0	V
Forward Transconductance	g_{fs}	V_{DS} = 25V, I_D = 4.6A, Note 5	3.4	–	–	mhos
Drain–to–Source Leakage Current	I_{DSS}	V_{DS} = 60V, V_{GS} = 0	–	–	25	μA
		V_{DS} = 48V, V_{GS} = 0V, T_C = +125°C	–	–	250	μA
Gate–Source Leakage Forward	I_{GSS}	V_{GS} = 10V	–	–	100	nA
Gate–Source Leakage Reverse	I_{GSS}	V_{GS} = –10V	–	–	–100	nA
Total Gate Charge	Q_g	V_{GS} = 5V, I_D = 10A, V_{DS} = 48V, Note 5	–	–	8.4	nC
Gate–Source Charge	Q_{gs}		–	–	3.5	nC
Gate–Drain (“Miller”) Charge	Q_{gd}		–	–	6.0	nC
Turn–On Delay Time	$t_{d(on)}$	V_{DD} = 30V, I_D = 10A, R_G = 12Ω, R_D = 2.8Ω, Note 5	–	9.3	–	ns
Rise Time	t_r		–	110	–	ns
Turn–Off Delay Time	$t_{d(off)}$		–	17	–	ns
Fall Time	t_f		–	26	–	ns
Internal Drain Inductance	L_D	Between lead, 6mm (0.25”) from package and center of die contact	–	4.5	–	nH
Internal Source Inductance	L_S		–	7.5	–	nH
Input Capacitance	C_{iss}	V_{GS} = 0V, V_{DS} = 25V, f = 1MHz	–	400	–	pF
Output Capacitance	C_{oss}		–	170	–	pF
Reverse Transfer Capacitance	C_{rss}		–	42	–	pF
Source–Drain Diode Ratings and Characteristics						
Continuous Source Current	I_S	(Body Diode)	–	–	7.7	A
Pulse Source Current	I_{SM}	(Body Diode) Note 1	–	–	31	A
Diode Forward Voltage	V_{SD}	T_J = +25°C, I_S = 7.7A, V_{GS} = 0V, Note 5	–	–	1.6	V
Reverse Recovery Time	t_{rr}	T_J = +25°C, I_F = 10A, di/dt = 100A/μs, Note 5	–	65	130	ns
Reverse Recovery Charge	Q_{rr}		–	0.33	0.65	μC
Forward Turn–On Time	t_{on}	Intrinsic turn–on time is neglegible (turn–on is dominated by L_S + L_D)				

Note 1. Repetitive Rating: Pulse width limited by maximum junction temperature.
Note 5. Pulse Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 2%.