NPTEL Online Certification Course
<Design of Power Electronics converter>
<Assignment Number 3>: Detailed Solution
Indian Institute of Technology Guwahati

From the datasheet enter the following:

Question 1. Gate resistor R_G used by manufacturer to measure turn ON/OFF times ... *(Ω)*

Answer 1. R_G = *1.2 Ω*

Question 2. The maximum value of total gate charge ... *(nC)*

Answer 2. Q_{gmax} = 270 *nC*

A buck converter needs to be designed with input voltage V_{in}= 100 V and switching frequency, f_s = 50 *kHz*. The MOSFET IRFP90N20DPbF is chosen for the design. A gate driver IC and gate resistor need to be chosen for the MOSFET. A voltage of V_G = 15 *V* is chosen to be applied for the gate drive circuit.

Question 3. Calculate the power required to drive the MOSFET, P_{gate} ... (*W*)

Solution 3. Given, V_G = 15 *V*, f_s = 50 *kHz*, Q_g = 180 *nC* (from datasheet)

$$P_{gate} = V_G \times Q_g \times f_s$$

$$= 15 \times 180 \times 10^{-9} \times 50 \times 10^{3}$$

$$= 0.14\ W$$

Question 4. Using the same value of R_G as used by manufacturer to measure turn ON/OFF times, calculate I_{g-pk} ... (*A*)

Solution 4. Given, V_G = 15 *V*, R_G = 1.2 *Ω* (from datasheet)

$$I_{g-pk} = \frac{V_G}{R_G}$$

$$= \frac{15}{1.2}$$

$$= 12.5\ A$$

Question 5. If I_{g-pk} needs to be limited to 2 *A*, what should be the value of R_G ... (*Ω*)? Solution 5.

Given, V_G = 15 *V*, I_{g-pk} = 2 *A*

$$R_G = \frac{V_G}{I_{g-pk}}$$
$$= \frac{15}{2}$$
$$= 7.5\ \Omega$$

Question 6. Assuming RMS gate current equal to 10% of 2 *A*, calculate power dissipated in gate resistor

I_{gRMS2} R_G ... (*W*)

Solution 6. I_{gRMS} = 0.1 × 2 = 0.2 *A*, R_G = 7.5 *Ω*

$$P_D = I_{gRMS2} \times R_G$$
$$= 0.2^2 \times 7.5$$
$$= 0.3\ W$$

Question 7. What should be the minimum power rating of gate driver IC ... (*W*) Solution 7.

P_{gate} = 0.14 *W* (from question 3), I_{gRMS}^2 R_G = 0.3 *W*

$$P_{min} = I_{gRMS}^2 \times R_G + P_{gate}$$
$$= 0.3 + 0.14$$
$$= 0.44\ W$$

Question 8. Which among the following gate drivers can be used for the above MOSFET?

a. FOD3150
b. FOD3180
c. TLP152
d. TLP351H

Answer 8. “b. FOD3180” or “c. TLP152”, only these two gate drivers satisfy the output gate current requirement.