DIODES INCORPORATED

DN1152
Gate Driver and MOSFET Compatibility

Introduction

When designing a power switching system, for example a motor driver, or a power supply, the designer must make important decisions. What motor or transformer to match the system requirements? What are the best MOSFETs or IGBTs to match that motor or transformer? And what gate driver IC is best matched to the MOSFET?

Choosing the right gate driver to match the MOSFETs is crucial to designing an optimal system. A wrong choice can decrease efficiency of the system by unnecessarily increasing switching losses of the MOSFET. But also a wrong choice can greatly increase noise, possibly increasing V_S undershoot, HO or LO spikes, and at the extreme, causing shoot-through that can damage the MOSFET and gate driver.

Gate Driver Source/Sink Current and MOSFET Total Gate Charge

MOSFET voltage and high-side floating well voltage of the gate driver should be considered for the system design (both to be about 20% greater than the motor voltage to allow for overshoot), but the most important parameter to match the gate driver and MOSFET is the gate driver source/sink current to the MOSFET total gate charge. The relationship is seen in the equation below:

$$Q_g = I \times t$$

Where Q_g is the total gate charge of the MOSFET, I is the source/sink current of the gate driver, and t is the rise and fall time of the MOSFET.

An example for choosing Diode's gate driver for a particular MOSFET

This example starts with knowing exactly which MOSFET you have and wanting to choose the optimal Diode's Gate Driver to match the MOSFET. Table 2 shows the total gate charge information for the MOSFET DMN10H099SK3. Note the test conditions for measuring the gate charge, most likely the conditions of the design are not the same as the test conditions used for total gate charge. Hence it is important to be aware that this calculation is estimation and the final rise/fall of the MOSFET may not be exactly the same used in the calculation.

For this example, if the required rise and fall time for an application is 20ns, then from the datasheet of DMN10H099SK3, the calculations would be:

$I = Q_g / t$

$I = 25.2nC / 20ns = 1.26A$

The DGD2184, DGD2181 would be a good choice as the sink/source current is 1.9A/2.3A, not exact but a close match. In addition, a means to further control rise/fall of the gate drive signal (and hence rise/fall of the MOSFET), is to use the gate resistor configuration as seen in Figure 1. Varying R_{Gon} will affect the rise time and varying R_{Goff} will affect the fall time. Increasing gate resistors will have the effect of decreasing noise, minimising V_S undershoot, and decreasing overall spiking, but at the expense of increasing losses in these resistors. But as long as the overall system efficiency is not affected, it is a fairly good trade-off considering the importance of system stability.

Diodes Gate Driver IC	Source / Sink Current	Q_g for rise / fall at 10ns (Note 1)	Q_g for rise / fall at 20ns (Note 1)	Q_g for rise / fall at 50ns (Note 1)	Q_g for rise / fall at 100ns (Note 1)	Q_g for rise / fall at 200ns (Note 1)
DGD2103A, DGD2104A	210 / 300 mA	3nC	5nC	13nC	25nC	50nC
DGD2101, DGD2103, DGD2104, DGD2106, DGD2108	290 / 600 mA	4nC	9nC	22nC	45nC	90nC
DGD2184, DGD2181	1.9 / 2.3 A	21nC	42nC	105nC	210nC	420nC
DGD2110, DGD2113	2.5 / 2.5 A	25nC	50nC	125nC	250nC	500nC

Note 1. These are approximate values, the sink and source current are not the same value, and hence in the real circuit the rise and fall of the MOSFET will not be the same.

Table 1: Diode's Gate Driver ICs and MOSFET Compatibility

How to Use MOSFET Compatibility Table?

Table 1 provides the means to choose the appropriate MOSFET (using the total charge, Q_g) while controlling the rise/fall of the MOSFET, and which Diode's Gate Driver would match these conditions. In the previous example, the fastest possible choice was selected. But there may be situations where the rise/fall times wants to be chosen, most likely slower, to provide a more stable system, particularly in motor driver applications.

Total Gate Charge (V_{GS} = 10V)	Q_g	—	25.2	—	nC	V_{DS} = 50V, I_D = 3.3A
Total Gate Charge (V_{GS} = 4.5V)	Q_g	—	12.2	—		
Gate-Source Charge	Q_{gs}	—	5.3	—		
Gate-Drain Charge	Q_{gd}	—	5.9	—		

Table 2: Total Gate Charge Example for MOSFET DMN10H099SK3

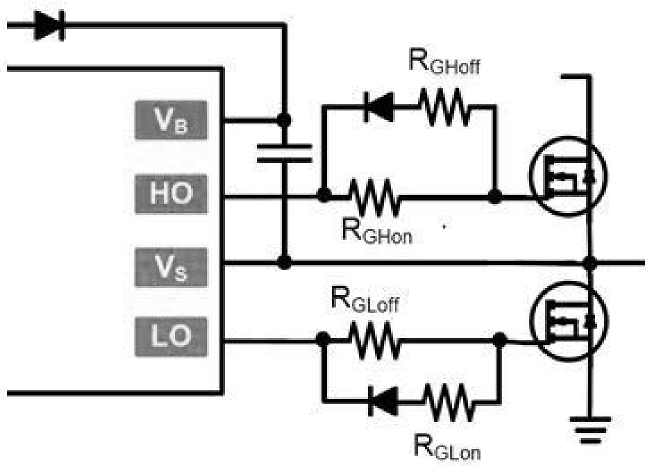

Figure 1: Using Gate Resistors to Control MOSFET Rise/Fall Time

Note also that this method is an approximation. First, as discussed before, the conditions for testing Q_g is rarely the same as the design conditions. Also a particular Q_g at a particular current will produce a single value for rise/fall. For most Diode's Gate Driver ICs, the source and sink current are not the same; hence the rise/fall time will not be the same. As an example, suppose you want to drive a 48V, 5A, BLDC motor and the design aim is to use the DGD2103 and have rise/fall of the MOSFET at approximately 50ns. The Diodes Inc. DMN10H099SK3 (100V, 20A) may be a good choice with a Q_g typical of 25nC. And the gate resistor configuration of Figure 1 can be used to further control the rise/fall of the MOSFET gate drive signal.