Reduce Motor Drive BOM and PCB Area with TI Smart Gate Drive

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Introduction

In an ideal world, gate drivers would connect directly to MOSFET gates and the motor drive system would operate perfectly. However, the real world creates a variety of issues for motor drive designers that cause them to add extra external components between a gate driver's outputs and the external power-stage FETs. The example in Figure 1 shows that each external power MOSFET may need up to four additional components for a designer to mitigate possible FET gate drive issues. For a three-phase driver, a designer might use up to twenty-four external components between the gate driver IC and triple half-bridge FETs.

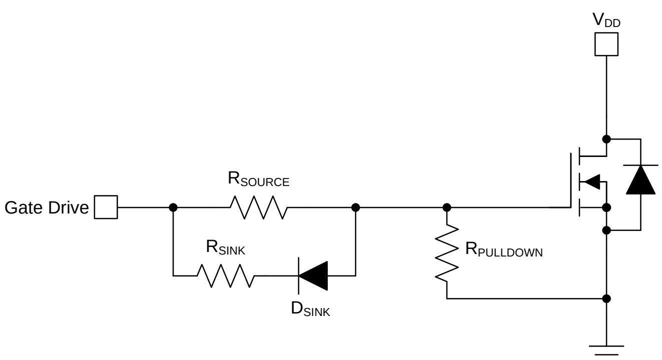

Figure 1. Additional components between gate driver and MOSFET

The main reasons designers add these components are to improve radiated electromagnetic interferance (EMI) performance, protect the gate driver and FETs, and eliminate unintentional FET turn-on from switching transients. Adding these components to the gate driver increases board area and bill of materials (BOM) cost in motor drive designs. TI's Smart Gate Drive features eliminate the need for these external components while helping designers meet their EMI, robustness, and performance goals.

How Smart Gate Drive eliminates components

The R_{SOURCE} and R_{SINK} resistors limit the gate current of the FET as it switches. By reducing the gate current, the FET gate capacitance takes longer to charge and discharge. This slows the slew rate of the FET as it switches. While R_{SOURCE} is sufficient to limit the turn-off slew rate for some designs, sometimes designers require a larger sinking current to turn off the FET faster and keep it turned off during transients on the switching node. The diode D_{SINK} puts the two resistors in parallel during turn-off for a larger sinking current.

Although FETs dissipate less power when they switch quickly, fast edges cause ringing in the parasitic inductances (traces, bond wires, leads) and capacitances (C_{GD}, C_{GS}, C_{DS}) in and around the FET (Figure 2). This ringing from the parasitic components contributes to EMI and causes voltage overshoot and undershoot transients on the switching node. These transients can damage the FET and gate driver by violating minimum and maximum voltage ratings.

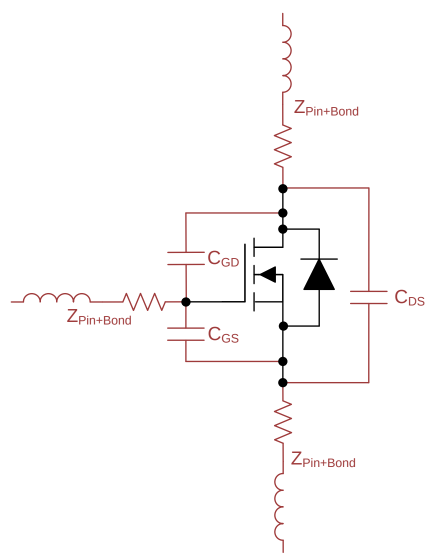

Figure 2. Some of the parasitic inductances and capacitances around a FET.

The Smart Gate Drive feature in TI motor drivers allows designers to select the gate drive source and sink currents without adding components to the gate-drive output. Figure 3 shows an example of how to select gate-drive currents using a single pin. Other devices use a serial interface to select the gate-drive currents. By configuring the gate-drive currents, designers can eliminate R_{SOURCE}, R_{SINK}, and D_{SINK}. This can save the BOM cost and PCB area of up to *eighteen components* between the gate driver and the power-stage MOSFETs.

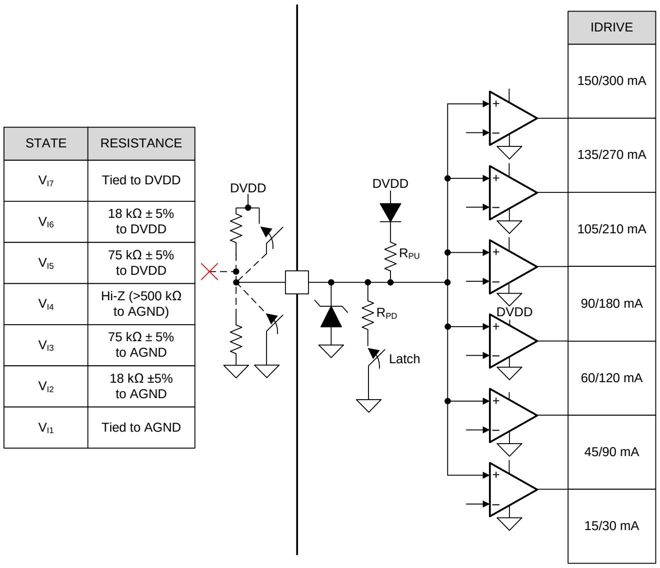

Figure 3. DRV8304H IDRIVE settings. See DRV8304 Product Folder for more information.

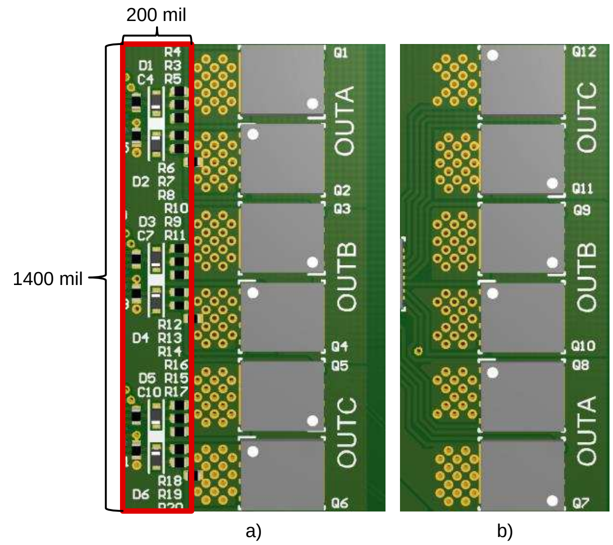

Figure 4. Example gate drive layouts for a three-phase driver.

Additionally, Smart Gate Drive eliminates the $R_{PULLDOWN}$ resistor by integrating it into the gate driver. This resistor helps to hold the FET gates low so they do not turn on from system noise coupling when the H-bridge FETs are disabled. By integrating the resistor, Smart Gate Drive can eliminate *six more components*.

Printed circuit board layout example

Figure 4 (a) shows a layout with components between the driver and the FETs. Figure 4 (b) shows how eliminating those components with Smart Gate Drive saves board space. Even though the components are small, their reference designators, traces, and geometry of the design require additional board area. The resistors and diodes in the Figure 4 example are 0402 packages (40 mil x 20 mil), but only use about 7% of the total area between the gate driver and the FETs. In this particular board example, Smart Gate Drive saves a total board area of about 180 mm^2 (0.28 in^2).

Conclusion

With Smart Gate Drive, TI motor drivers bring the ideal world closer to reality. Smart Gate Drive addresses FET driving concerns while reducing a motor drive system's bill of materials (BOM) and PCB area by around *twenty-four components*. For more details, see the *Understanding IDRIVE and TDRIVE in TI Smart Gate Drivers* application report.

Table 1. Device Recommendations

Device	Description
DRV832x	60-V Three-Phase Smart Gate Driver with Three Current Shunt Amplifiers and Buck Regulator
DRV835x	100-V Three-Phase Smart Gate Driver with Three Current Shunt Amplifiers and Buck Regulator
DRV8305	45-V Three Phase Gate Driver with Three Current Shunt Amplifiers and LDO Regulator
DRV8304	38-V Three-Phase Smart Gate Driver with Three Current Shunt Amplifiers

Related Documentation

- *Understanding IDRIVE and TDRIVE in TI Smart Gate Drivers*
- *Field Oriented Control (FOC) Made Easy for Brushless DC (BLDC) Motors Using TI Smart Gate Drivers*

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