Technical Article

A Basic Brushless Gate Driver Design – Part 3: Integrated vs. Discrete Half Bridges

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Dec 16, 2020

Integrated multi-half-bridge drivers are becoming more popular as designers push the envelope on what's possible within their ever-shrinking printed circuit board (PCB) designs. PCBs are getting smaller while power levels and feature requirements are growing. This leaves some engineers wondering whether it's better to stick with their traditional discrete half-bridge design or move to a more integrated three-phase design such as the DRV8320. In this article, I'll take a quick look at the pros and cons of this decision by looking at data that may help influence the selection of the right integrated circuit (IC) for brushless-DC motor drives.

Let's start with a list of the differences between the integrated and discrete approaches. The designs that I'm comparing are the same ones used in Part 1 and Part 2 of this technical article series.

Discrete half-bridge gate-driver design

- **Advantages:**
  - Layout simplicity. It is possible to copy the same half-bridge layout multiple times to support one, three or six half bridges, since each half bridge has its own IC and external components. Using a dedicated motor driver IC for each half bridge can also result in shorter traces between the gate driver and metal-oxide semiconductor field-effect transistors (MOSFETs, which are commonly referred to as FETs), which can reduce parasitic elements on the board (more on this later!).
- **Disadvantages:**
  - Higher external component count. The components you'll need for the external power supply, system protection and FET control add layout complexity and board space.
  - Protection features. Protection features are limited or missing in simple discrete half-bridge gate drivers. Adding these features externally, however, increases system complexity, layout and schematic efforts.

Integrated gate-driver design

- **Advantages:**
  - High level of integration. The supporting components for the FET gate drive and power supplies are integrated into the gate driver, which reduces bill-of-materials (BOM) and assembly costs for components such as series gate resistors, gate sink path diode, gate-to-source voltage (VGS) clamp diode, gate passive pulldown resistor and power supplies.
  - Added protection features. Drain-to-source voltage (VDS) and VGS monitors, along with current-shunt amplifiers, seamlessly protect the external FETs, PCB and motor, with no external components needed.
  - System simplicity. One integrated circuit controls all motor functions with combined fault reporting and single-point motor driving or shutdown.
- **Disadvantages:**
  - Layout complexity. One driver means that you must route traces out to six FETs from one central point, which can make traces longer and might add to PCB parasitic effects (more on this in the next section!).

Often, the PCB layout parasitic differences are the major design distinction between using integrated and discrete gate drivers. Conventional wisdom states that integrated layouts need longer gate and source traces, which causes the parasitic effects to be worse than a discrete approach.

Using modeling and simulation software, I analyzed the layouts compared in Part 2 of this series for parasitic inductance and resistance in order to get a true look at the differences between the designs. Figure 1 summarizes my findings.

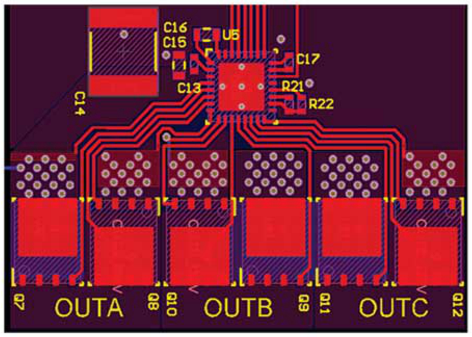
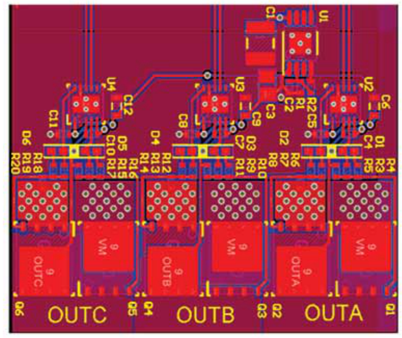
DRV8320 integrated driver design	Discrete design
	
GHx trace length: min = 660 mil, max = 851 mil	GHx trace length: 794 mil
GHx trace width: 10 mil	GHx trace width: 10 mil
Inductance: min = 15.11 nH, max = 21.16 nH	Inductance: 17.0 nH
Impedance: min = 23.3 mΩ, max = 30.0 mΩ	Impedance: 26.4 mΩ plus the discrete resistor

Figure 1. Integrated vs. discrete gate-driver comparison (Note: The integrated approach has one closer half bridge [phase B] and two farther ones [phases A and C], while the discrete approach has the same layout copied three times. That is why the integrated design lists a minimum and maximum, while the discrete design lists only one value for each parameter.)

To my surprise, the parasitic inductance and impedance for integrated and discrete half-bridge gate drivers show very little difference. The integrated gate driver does not increase parasitic element values significantly. The benefits of essential protection, reduced BOM and reduced solution size still apply.

In summary, integrated gate drivers such as the DRV8320 are great candidates for reducing the size of discrete designs and are sure to put an elegant “spin” on your brushless-DC product.

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