Technical Article

How Analog Integration Simplifies Automotive Body Motor Controller Designs

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Automotive body electronics systems use electric motors to enhance comfort and convenience for vehicle occupants whether it's adjusting the perfect seat position or easily opening the trunk.

Metal-oxide semiconductor field-effect transistors (MOSFETs) – arranged in the shape of the letter "H" – control the electric motors for these applications. But using MOSFETs as switches presents new technical challenges in electronic control module designs, including electromagnetic interference (EMI) and thermal management, current sensing, power-off braking, and diagnostics and protection. The broad portfolio of integrated circuit (IC) motor driver products developed by Texas Instruments integrate analog features that help electronic control module designers overcome these challenges while reducing solution size and shortening development times. Moreover, the products range from single half-bridge to multiple H-bridge gate drivers products that allow you to easily scale your designs based on your specific design implementation.

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In this article, we will discuss specific analog features integrated in motor drivers ICs that help address these design challenges.

Mitigating EMI

EMI mitigation is achieved using features and solutions both at IC level and at printed circuit-board (PCB) level. One key method to mitigate to EMI is control of pulse width modulation (PWM) edge rates. Gate driver products such as DRV8705-Q1 , DRV8706-Q1 , DRV8714-Q1 and DRV8718-Q1 gate drivers for brushed DC

(BDC) motors, and three-phase DRV8343-Q1 for brushless DC (BLDC) motors all integrate smart gate-drive technology, which is specifically used to control the PWM edge slew rates. Furthermore, these devices offer the ability to select slew rate that best mitigates EMI. Another common technique used to reduce EMI is dithering the main clock frequency. DRV10983-Q1 three-phase BLDC motor driver with integrated MOSFETs also integrates dithering of the main clock frequency, thus reducing the amplitude by spreading the peak across the spectrum

Managing thermals

Motor operating and stall currents have a wide range of values based on the load being driven. For high current loads, gate-driver products give you the choice of implementing your designs using discrete MOSFETs. Electronic control module designers can optimize layout and thus achieve optimal thermal management . For low load current loads, devices such as DRV8873-Q1 , DRV8874-Q1 and DRV8876-Q1 with integrated H-bridge MOSFETs can be used to drive the loads while achieving optimal thermal management. Moreover, for low current loads driven by three-phase BLDC motors, DRV10983-Q1with integrated MOSFETs can be used. Note that DRV10983-Q1 also integrates the commutation algorithm, enabling single-chip solution to drive the motor.

Current sensing

The current in the motor is measured to detect circuit and motor faults, and to infer motor position using ripple counting. All TI BDC and BLDC motor- and gate-driver products integrate current- sense amplifiers to amplify the voltage across the resistor. Furthermore, the DRV8106-Q1 , DRV8706-Q1 , DRV8714-Q1 and DRV8718-Q1 offer an in-line current-sense amplifier. Using in-line current sense measurements, the direction of motor rotation can also be determined. Windows are traditionally driven using BDC motors. However, system designers are investigating the use of BLDC motors to drive the window because BLDC motors are quieter. In addition, BLDC motors are also being considered for rotating the seat base in autonomous vehicles. The 3-phase smart gate driver DRV8343-Q1 which integrates the current sense function can be used in these applications.

Power-off braking

With MOSFET solutions, a motor can be rotated freely when power to the motor is turned off. In such cases, moving the load manually, for example, opening or closing a power trunk manually, could result in large back EMF which could damage the electronics. The DRV8714-Q1 and DRV8718-Q1, targeted for trunk control module applications, integrate a power-off braking feature , which measures the voltage being generated and applies electronic brakes to the motor. This feature stops the motor from rotating, which in turn stops the generation of current.

Diagnostics and protection

Detecting circuit faults and protecting the systems against these faults is an important requirement when controlling motors. The BDC and BLDC gate drivers integrate diagnostic circuits to detect open and short circuits. In addition, we also provide failure-mode distribution and pin failure mode analysis information for some ICs to aid functional safety design when needed.

Implementing control modules in body applications

Table 1 maps the products to the motors used in these applications.

Table 1. A selection of products available for body motor applications

Control module	Load	Products
Door	Single window with BDC motor	DRV8705-Q1, DRV8706-Q1
	Door lock motor Dual window with BDC motor	DRV8714-Q1, DRV8718-Q1, DRV8873-Q1
	Single window with BLDC motor	DRV8343-Q1
	Mirror X/Y motor Mirror fold motor	DRV8908-Q1, DRV8873-Q1
Roof	Roof motor	DRV8705-Q1, DRV8706-Q1
	Multiple roof motor	DRV8714-Q1, DRV8718-Q1
Trunk	Single trunk lift BDC motor	DRV8705-Q1, DRV8706-Q1

Table 1. A selection of products available for body motor applications (continued)

Control module	Load	Products
	Multiple trunk lift BDC motors	DRV8714-Q1, DRV8718-Q1
	Single trunk lift BLDC motor	DRV8343-Q1
	Trunk cinch motor	DRV8873-Q1
Seat	Seat position adjust motor	DRV8718-Q1, DRV8714-Q1
	Lumbar support bladder pump motor	DRV8873-Q1, DRV8874-Q1
	Seat ventilation motor	DRV10983-Q1
	Seat base rotation motor	DRV8343-Q1

Additional resources:

- Learn more about BDC and BLDC motor drivers.
- Read the application report, "Understanding Smart Gate Drive."
- Read these technical articles: "What is a smart gate-drive architecture? – Part 1" and "Integrated intelligence part 1: EMI management."
- Check out the white paper, "Smart Gate Drive."
- Start designing with the Single-Layer, 12-V, Programmable, 3-Phase BLDC Motor Driver with Speed Regulation Reference Design.
- Watch the automotive electric motor EMC overview

Moreover, the products range from single half bridge products to multiple H-bridge gate driver products that all you to easily scale your designs based on specific design implementation.

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