

New product update

Eliminating brushed DC encoders
with ripple counting

Karan Doshi

Systems Engineer

Motor Drives – Brushed, Stepper, Solenoids

Agenda

- Introduction to DRV8214 and DRV8234
- What is ripple counting?
- Why sensorless control mechanisms?
- Example cost and feature benefit study
- Why DRV8214 or DRV8234 over existing motor drivers?
- End equipment application examples
- Technical collateral and product folders

Jacob Thompson and Shreya Mandal will take questions in the chat. Feel free to ask all queries you have!

DRV8214/DRV8234: Sensorless speed and position control devices

H-bridge motor driver with I2C, stall detection, speed regulation and position sensing using **Ripple Counting**

Specs

Part number	Operating supply voltage	$R_{\text{DS(on)}} @ T_a=25\text{C}$ (HS +LS)	RMS current	Overcurrent protection
DRV8214	11V	240m Ω	2A	4.0A
DRV8234	38V	600m Ω	2A	3.7A

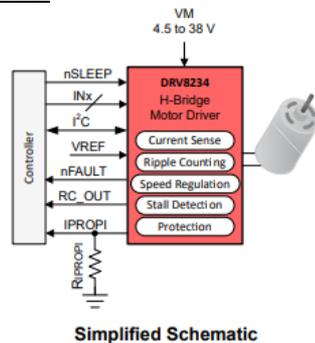
First integrated devices in the market!

Applications

- Major and small appliances
- Vacuum, humanoid and toy robotics
- Coffee machines
- Printers
- Smart locks
- Servo motors and actuators

Benefits and Features

- Sensorless motor speed and position detection with ripple counting
- Maintain consistent motor speed with integrated speed regulation
- Improved system diagnostic and reliability through hardware stall detection
- Eliminate shunt resistors and external sense resistors with integrated current sensing
- Save energy through programmable voltage regulation
- Customize configurations and identify fault conditions with I2C interface
- Reduce PCB space with integrated charge pump regulator and capacitors
- Increase reliability and longevity by reducing inrush current using soft-start



16-pin QFN, 3mm x 3mm, 0.5mm pitch

What is ripple counting?

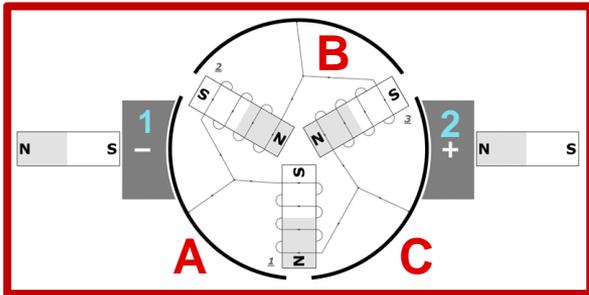


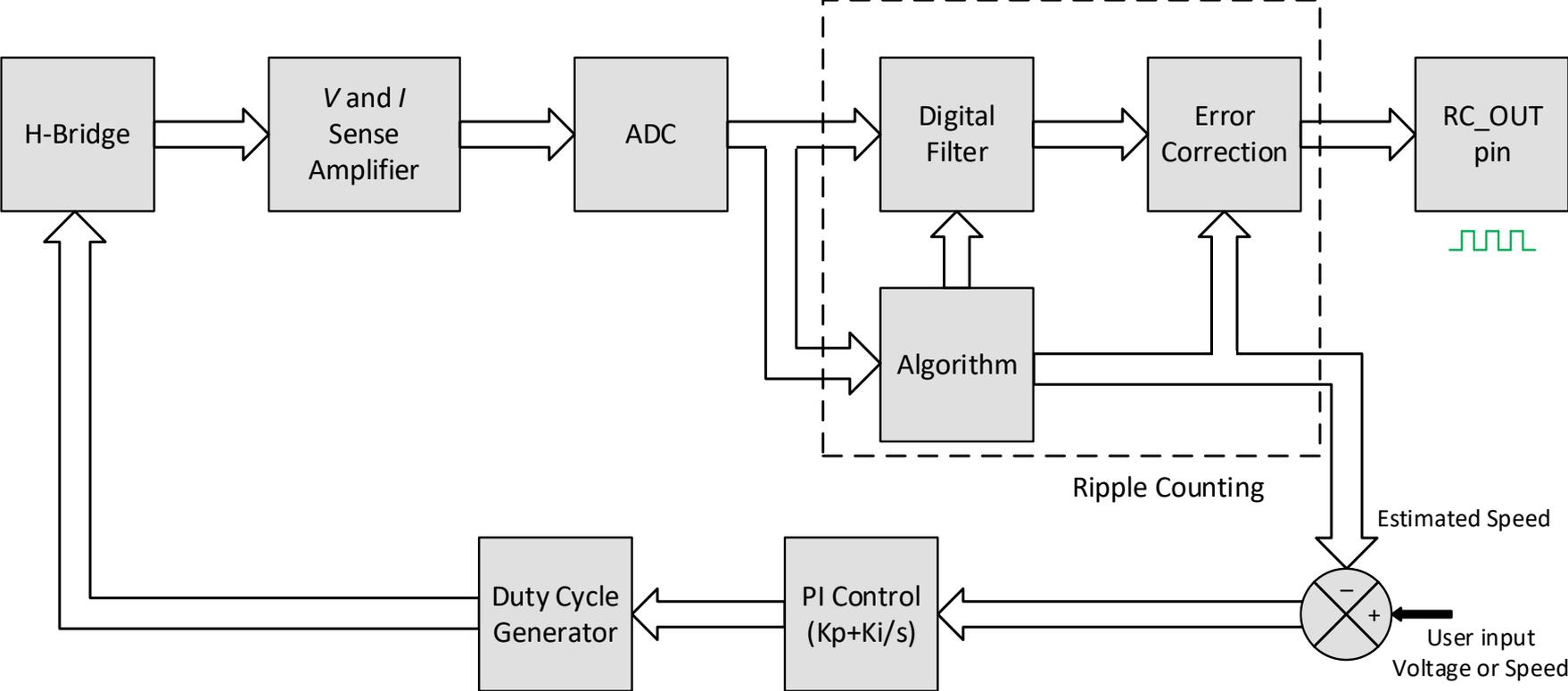
Diagram of a Brushed DC motor

- Commutation in brushed DC motors → Ripples in motor current
- Device “counts” the number of ripples per revolution
- Eg: 2 Brushes × 3 Commutators = 6 ripples



Red arrows indicate repeatability of ripple current waveform. Above scopeshot shows 6 ripples per revolution.

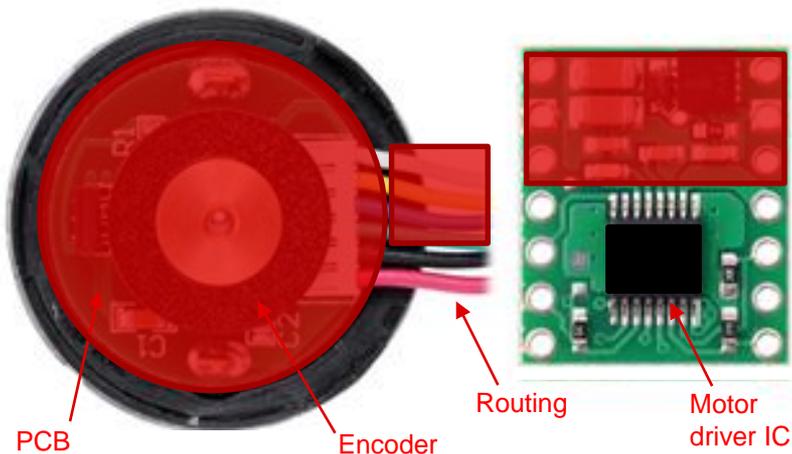
Functional block diagram



Why sensorless control?

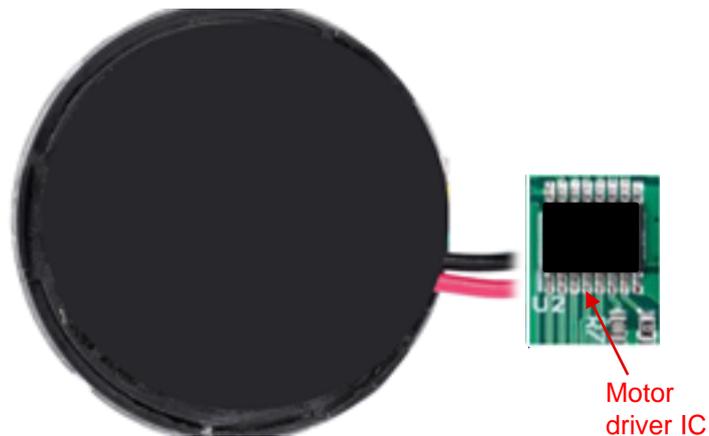
BEFORE

- × Expensive components
- × Complex to design
- × Takes up space

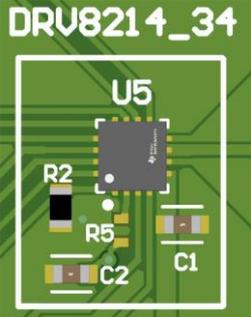


AFTER

- ✓ BOM savings (\$0.25 – \$0.50)
- ✓ Easy to design
- ✓ Up to 85% reduction in size



DRV8234 versus Existing: Example benefit study

DRV8234 (I2C, ripple counting, stall detect, current sensing & regulation, etc.)	Motor drivers today
<u>DRV8234</u> (38V driver) 1ku price: \$1.25	Existing 38V drivers 1ku price: \$0.60 - \$0.80 
VM/GND Motor wires and assembly: \$0.05 	VM/GND Motor wires and assembly: \$0.05 
 <div data-bbox="349 626 929 832" style="border: 2px solid green; padding: 5px;"><ul style="list-style-type: none">+ Stall Detection+ I2C Interface+ System Complexity Reduction+ Reduced Power Consumption</div>	2x Hall sensors (TMAG5231): \$0.11  Wiring and connectors for hall sensors: \$0.10 (2.5x wiring for motor) (driver could be near/far from hall sensor) 
	Hall sensor PCB: \$0.10 
	Magnets + assembly: \$0.25
	MCU Requirements for Hall Sensors (pins, interrupts, etc.): \$0.10
Total Cost: \$1.30	Total Cost: \$1.51

Why DRV8214/DRV8234?

Feature	Benefit
<u>Ripple counting - Sensorless position detection</u>	Sense and control motor position relative to start
<u>Motor voltage and speed regulation</u>	Regulate motor voltage or speed to ensure constant actuation time despite variation in battery voltage with closed loop PI control
<u>Stall detection</u>	Detect a stall condition or end-of-travel
<u>I2C Interface</u> Programmable driving profiles, current regulation, stall detection, diagnostics reporting	Reduced number of GPIO for high motor-count systems, can provide advanced diagnostic feedback, or reduce firmware control effort
<u>Current sense feedback (IPROPI)</u>	Provide analog current info back to MCU to track mechanical loading*
<u>Current regulation</u>	Set a current limit to regulate inrush and stall currents
<u>Soft Start</u>	Ramp current slowly to preset value to counter high inrush currents
<u>Gain Select (DRV8214 only)</u>	Configure low-side MOSFET $R_{\text{DS(on)}}$ for high accuracy current sensing down to 10mA
<u>Overvoltage protection</u>	This feature puts the driver into the brake state when the motor is spun manually, acting like a generator. This eliminates the issue of large voltages occurring on the supply rail and damaging the driver and other circuits

*Digital current information can be obtained via I2C too

Example EE 1: Vacuum robots



Main Brush Motor

- Brushed DC Motor
- 2A RMS Current



Wheel Motor

- Brushed DC Motor
- <1.5A RMS Current



Side Brush Motor

- Brushed DC Motor
- <1A RMS Current



Vacuum Pump

- Brushed DC Motor
- <2A RMS Current

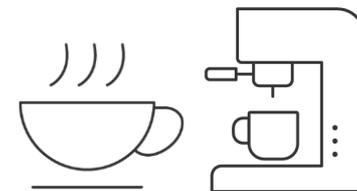
Vacuum robot system information

- Brushed motors used for wheels, side brush based on size and design (mop/vacuum version)
 - Typically 12V or 24V, up to 1.5A continuous current for wheels
 - Depending on complexity, designs may have one or two side brushes
 - Brushed DC motor also used for the pump

Product viability in your system

- [DRV8234](#) Brushed DC motor driver:
 - Wide-operating range: 4.5-38V, 3.7A peak
 - Integrated position sensing and speed regulation with Ripple Counting removes position and speed sensing encoders
 - Configurable Integrated Stall detection via I2C to aid obstacle detection
 - I2C permits easy communication between MCU and driver eliminating external hardware
 - [Integrated current sensing](#) removes the need of a sense resistor saving BOM cost and board space
 - IPROPI current feedback (analog) so the MCU can monitor and adjust the current delivered without external ICs. Digital current feedback available via I2C.
 - Available in the small 3x3 mm² QFN option
 - Refer to [this application note](#) for Ripple Counting in Robotic Wheel Drives

Example EE 2: Coffee machines



Coffee machine system information

- Brushed motors used for pump drive, centrifuge, frothier and grinder
 - Typically 12V or 24V, up to 2A continuous current
 - Need speed regulation for constant speed rotation of spinning centrifuge to grind beans at high rpm values
 - Position detection needed for pump for liquid flow detection. Eliminates hall sensors + Encoders

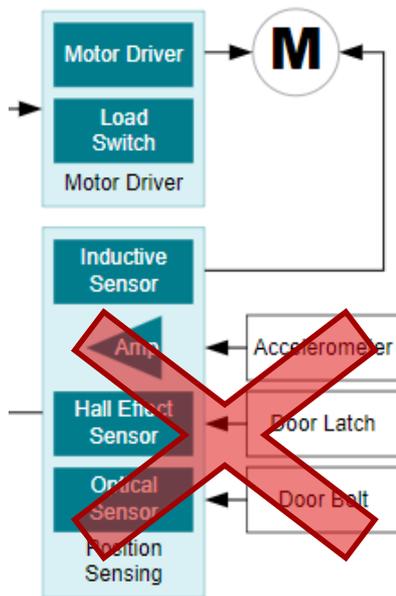
USE CASES

1. Spinning Centrifuge to grind beans
2. Pump Motor for liquid flow detection

Product viability in your system

- [DRV8214/DRV8234](#) Brushed DC motor driver:
 - Wide operating range. [DRV8214](#): 1.65-11V, 4A peak. [DRV8234](#): 4.5-38V, 3.7A peak
 - Integrated position sensing and speed regulation with Ripple Counting removes position and speed sensing encoders
 - Configurable Integrated Stall detection via I2C to detect motion obstruction
 - I2C permits easy communication between MCU and driver eliminating external hardware
 - [Integrated current sensing](#) removes the need of a sense resistor saving BOM cost and board space
 - IPROPI current feedback (analog) so the MCU can monitor and adjust the current delivered without external ICs. Digital current feedback available via I2C.
 - Available in the small 3x3 mm² QFN option

Example EE 3: Smart locks



Smart lock system information

- Brushed motors used for deadbolt actuation
 - Typically <11V up to 1A continuous current
 - Position detection needed to monitor deadbolt travel
 - Stall Detection useful to detect end of travel for added security
 - Speed/voltage regulation beneficial for smooth movement
 - Ultra-low power consumption needed in battery operated devices

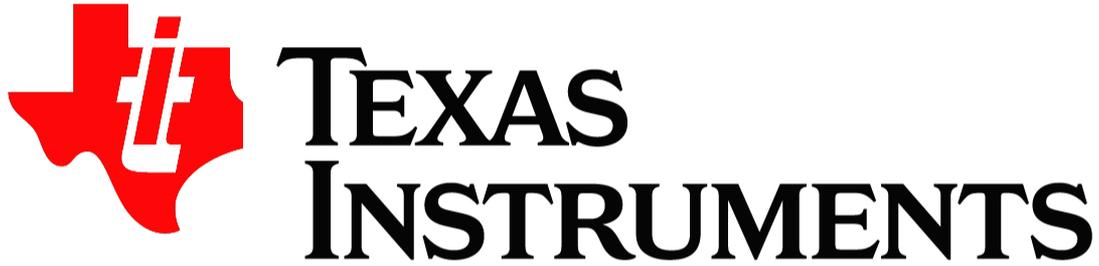
Product viability in your system

- [DRV8214](#) Brushed DC motor driver:
 - Operating range: 1.65-11V, 4A peak. 1.65V min voltage beneficial to battery applications
 - Low power consumption during “sleep” mode. “On-state” current consumption ~ 1mA
 - I2C communication frees up MCU pins for additional smart lock features
 - [Integrated current sensing](#) and IPROPI current feedback (analog) allows current monitoring while offering compact size. Digital current feedback also available via I2C
 - Available in the small 3x3 mm² QFN option

Getting started

You can start evaluating this device leveraging the following:

Content type	Content title	Link to content or more details
Product folder	Product pages	DRV8214 , DRV8234
Technical blog content or white paper	Solving sensorless brushed DC motor position and speed control using ripple counting	Application note
Selection and design tools and models	Transforming your motor control system with ripple counting – Sensorless position control for brushed DC motors	Application brief
Development tool or evaluation kit	Evaluation module for brushed DC motor driver with stall detection and ripple counting (with GUI)	DRV8214EVM , DRV8234EVM
Development tool training material	Sensorless position control – GUI Walkthrough video DRV821x and DRV823x Evaluation module user's guide	GUI Training video , EVM User's guide



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