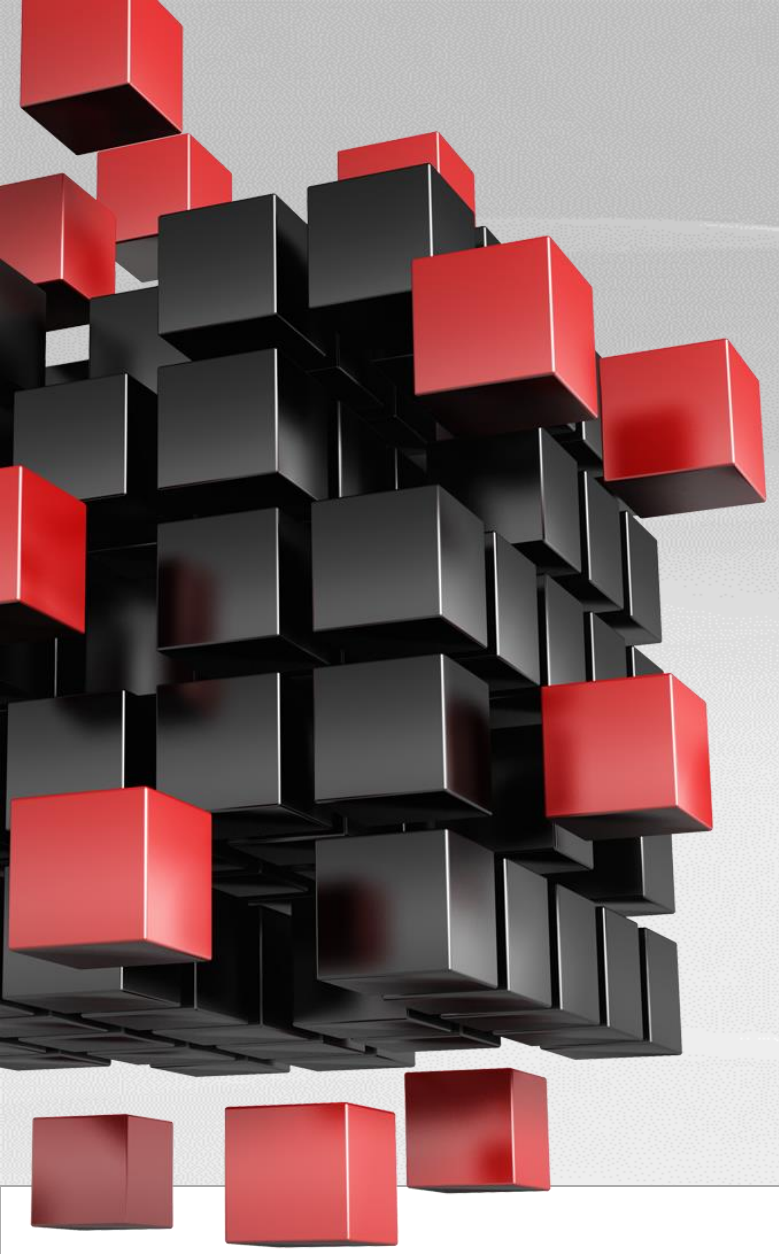

Automotive

Haptics for steering wheels
Haptics for console control
Smart Glass

January, 2017

SLYW060

Texas Instruments

Automotive Haptics | Use Cases

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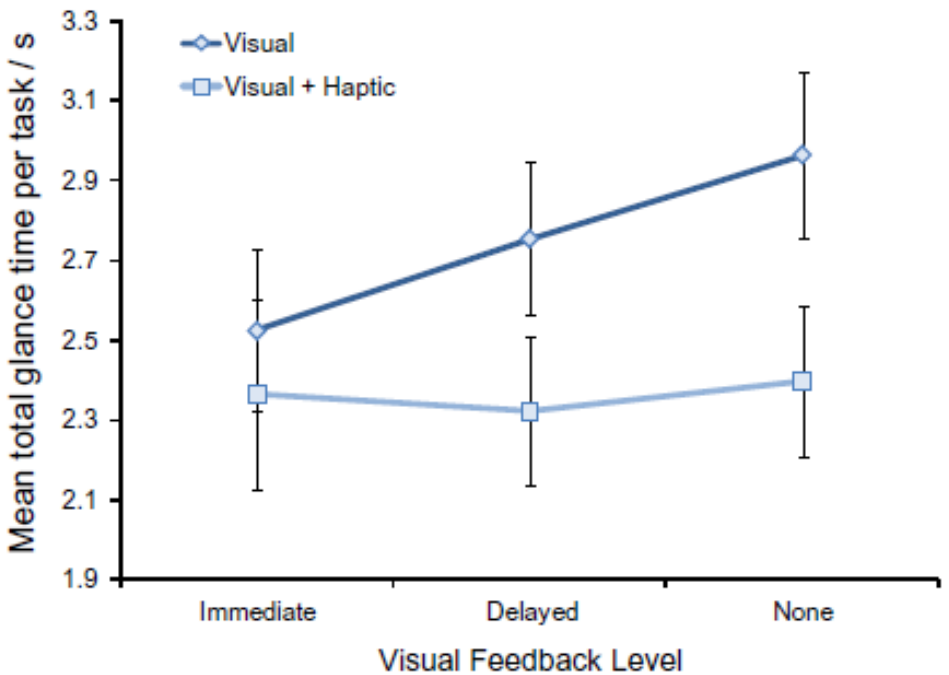
Automotive Haptics | Safety

- Haptic feedback makes for a safer drive!
  - *"Over 70% of the task completion time is spent looking at the touchscreen, confirming the visual nature of touchscreen interaction." (Pitts et al., 2011)*



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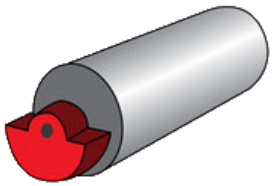
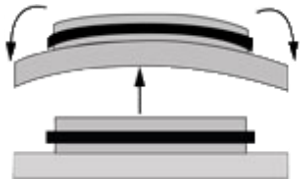
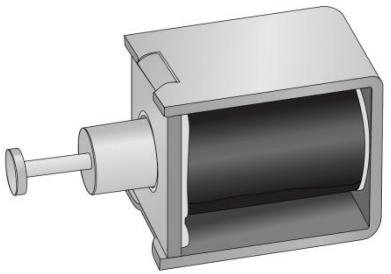
Actuator Technologies







Specifications	ERM	Piezo	Solenoids
Driving Voltage	1V - 5V or more	50Vpp - 200Vpp	1V - 12V or more
Driving Waveform	DC	AC Continuous/Pulse	AC Pulse
Acceleration	1g – 2g or more	2g – 5g	2g – 5g or more
Response Performance	Slow	Fast	Fast
Application	Driver Alerts	Touchscreen/Touchpad + Button Replacement	Touchscreen/Touchpad + Button Replacement + Driver Alerts
Vendors	Johnson Electric Nidec	BeStar	Johnson Electric Gruner
Automotive Qualified	Qualified	Pending	Qualified
TI Drivers	DRV2605L-Q1	DRV2700-Q1	DRV2510-Q1 DRV2511-Q1 DRV2516-Q1

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DRV2605L-Q1

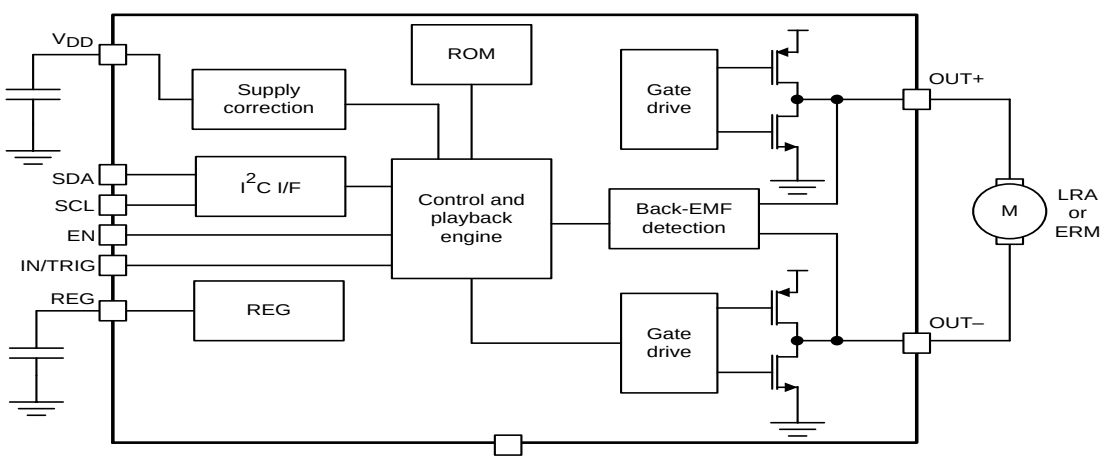
ERM/LRA Driver with Auto-Resonance and Integrated Waveform Library

Features

- Drive with Back-EMF Feedback
- Integrated Immersion Library
- I²C Controlled Haptic Effect Generator
- Hardware Trigger Options
- Automatic Calibration
- Automatic Actuator Diagnostic
- Accepts External PWM and Real Time I2C Bypass
- 2V - 5.2V Operation
- Fast Haptic Response Time
- 1.5mm x 1.5mm BGA (MSOP)

Benefits

- Simplified Input, Automatic Overdrive and Braking
- Simplifies implementation
- Relieves host processor from Haptic generation
- Low Latency
- Consistent Performance
- Troubleshooting hooks for production line
- Flexible Signal Input Options
- Direct Connection to Battery with Constant Gain
- Excellent User Experience
- Small Size, few external components



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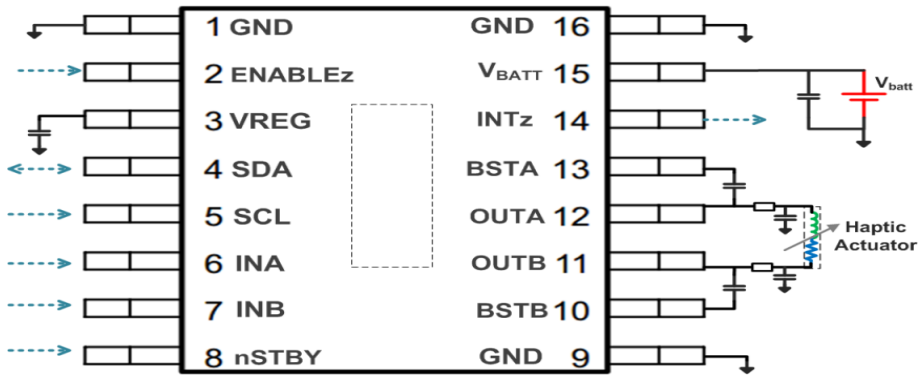
DRV2510-Q1

3A Closed-Loop Solenoid & DC Motor Driver

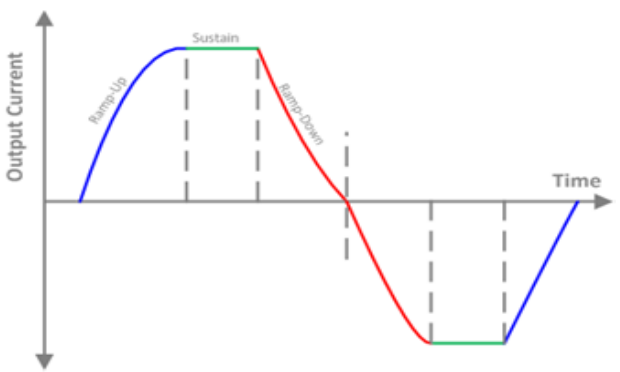
Features

- Wide Operating Voltage (5V to 18V)
- 16-Pin TSSOP package (6mm x 5mm)
- Closed Loop Drive Architecture (Voltage Feedback)
- I2C Interface
- Low-Power Stand-By Mode
- Integrated Actuator Diagnostics
- Integrated Fault Protection



Benefits

- Integrated 40V Load-Dump protection
- Compact Solution Size
- Consistent performance across V_{BATT} variation
- Fast Start-Up ensures very low latency
- Robust & Reliable solution



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DRV2511-Q1

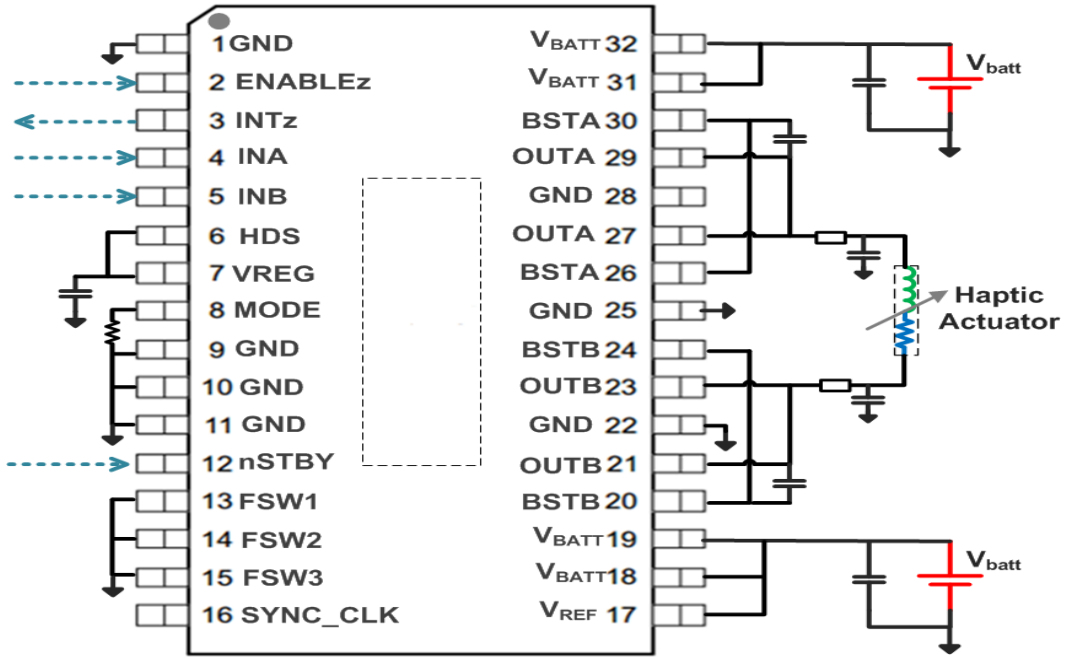
8A Closed-Loop Solenoid & DC Motor Driver

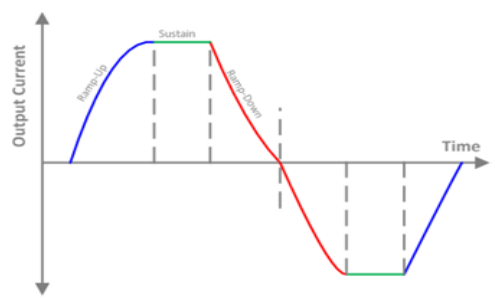
Features

- Wide Operating Voltage (5V to 18.5V)
- 32-Pin TSSOP package (8mm x 11mm)
- High Current Drive 8A
- Closed Loop Drive Architecture (Voltage Feedback)
- Low-Power Stand-By Mode
- Integrated Fault Protection
- Configurable Switching Frequency

Benefits

- Integrated 30V Load-Dump protection
- Compact Solution Size
- Consistent performance across V_{BATT} variation
- Fast Start-Up ensures very low latency
- Robust & Reliable solution





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TI Solenoid Comparison

Part Number	DRV2510	DRV2511	DRV2516
Input Voltage	5V - 18 V	5 V - 18.5 V	5 V - 18 V
Output Stage	Class D	Class D	Class D
Maximum Current	3 A	8 A	6 A
Load Dump Protection	40 V	30 V	40 V
Integrated Fault Protection	yes	yes	yes
Integrated Actuator Diagnostics	open/short	no	open/short
Voltage Control	yes	yes	no
Current Control	no	no	yes
I2C Interface	yes	no	no
SPI Interface	no	no	yes
Analog Input	yes	yes	no
Go-To-Standby	N/A	N/A	Automatic
Shutdown mode	yes	yes	yes
Consistent Output Over Battery	yes	yes	yes
Integrated RAM	no	no	2 kB
Waveform Sequencer	no	no	yes
Waveform Generator	no	no	yes
External Trigger	no	no	yes
Interrupt Pin	yes	yes	yes

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Smart Glass

Smart Glass | A better cabin light control

- Smart Glass uses electricity to increase or reduce light entering the cabin
- Reduces brightness and controls radiant heat gain
- Better control of brightness in sun roofs
- Allows glass on one side of car to be darker than the other
- Darkness can be limited to meet state regulatory requirements

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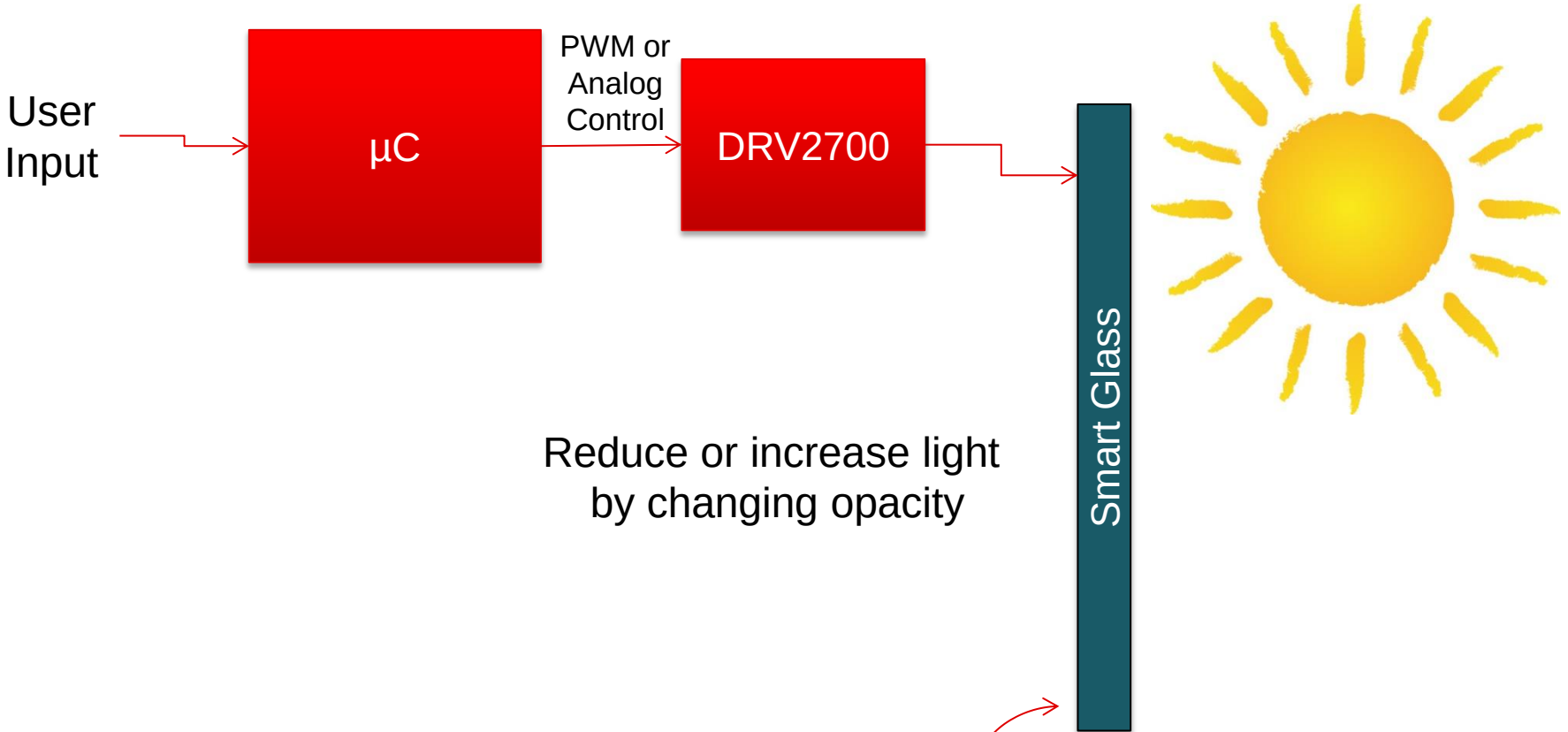
Smart Glass | Example System Diagram



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DRV2700-Q1

200Vpp, 500Vp Piezoelectric Actuator Driver

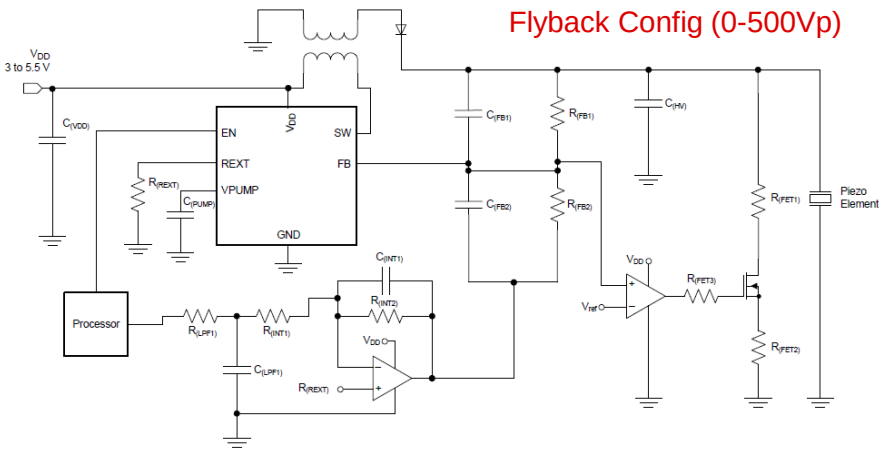
Features

- 40 VPP to 200 VPP Output (Boost+amp mode)
- Up to 500Vp Output (Flyback mode)
- Boost Converter with Integrated FET & Diode
- Adjustable Boost Voltage (15-105V)
- Adjustable Boost Current Limit (<2.25A)
- Small-signal bandwidth to 20kHz
- Thermal Protection

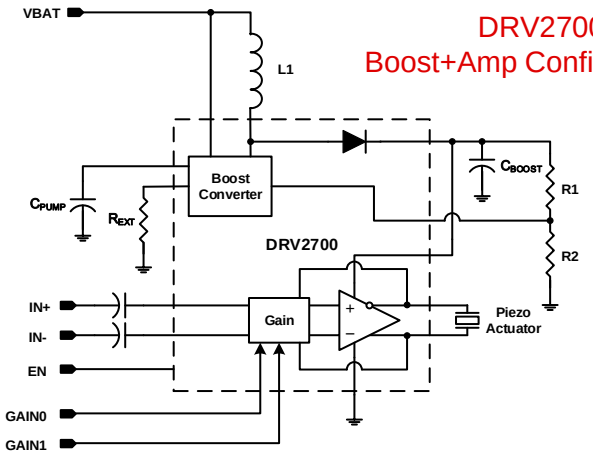
Benefits

- Drives bi-directional piezo actuators
- Drives high voltage into uni-directional piezos
- 90% Smaller footprint vs. discrete circuit
- Optimized voltage for application
- Inductor & current drive sized to application
- Fast startup from shutdown

DRV2700EVM-HV500
Flyback Config (0-500Vp)



DRV2700EVM
Boost+Amp Config (40-200Vpp)



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Haptic Feedback for Steering Wheels

Haptics | Driver Assistance Vibration Alerts

Driver Assistance Applications

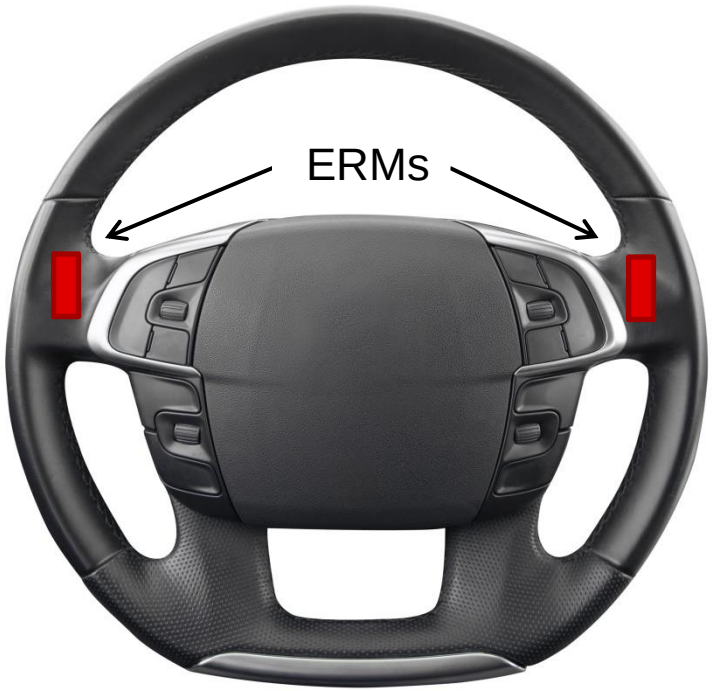
Parking assistance alert

Blind spot alert

Lane change and forward collision alert

Key Features

- AEC-Q100 Qualified
- Smart-Loop Architecture
- 123 Immersion-licensed haptic effects
- Wide Support for Actuator Models
- 0.7ms startup time
- 4 uA shutdown current



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