Haptics

Solutions for ERM and LRA Actuators

Texas Instruments

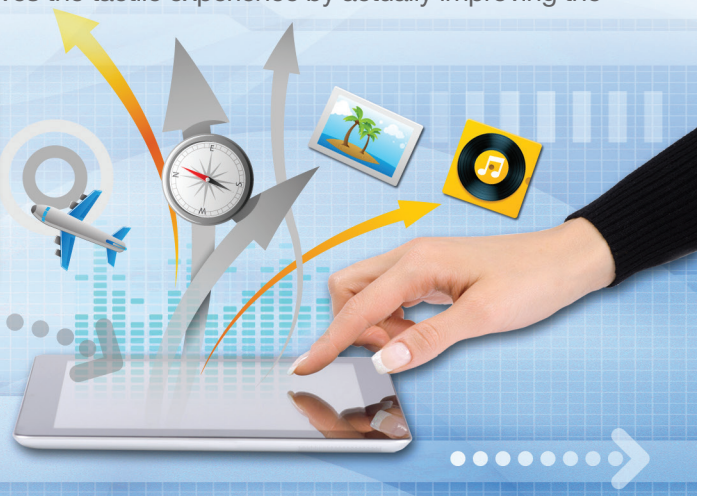
Overview

Texas Instruments is the leader in driver technology for haptic applications. Our drivers increase performance and decrease integration time of haptics into your system. Only TI offers a total touch solution with a complete portfolio of haptic drivers for any application.

The eccentric rotating mass (ERM) motor and linear resonant actuator (LRA) are two of the most common types of haptic actuators used in the market today. TI driver technology improves the tactile experience by actually improving the performance of these actuators.

Solution Characteristics to Consider

- Response Time – the start and stop time of the actuator
- Vibration Strength – the maximum acceleration achievable by the actuator
- Power Consumption



ERM & LRA Drivers

These features, only available from TI, help improve actuator performance and reduce integration time.

Waveform Library
123 haptic effects embedded, royalty free

Auto-Resonance Detection
Automatically track the resonant frequency of an LRA; maximize vibration strength and improve consistency across devices

Audio-to-Haptics
Convert audio signals to haptic effects; automatic haptics for music, games, and movies

Automatic Diagnostics
Automatically detect the status of the actuator

Automatic Calibration
Automatically detect and configure the closed-loop feedback coefficients for every actuator

Closed Loop Feedback
Improve the response time of ERM and LRA actuators with automatic overdrive and braking

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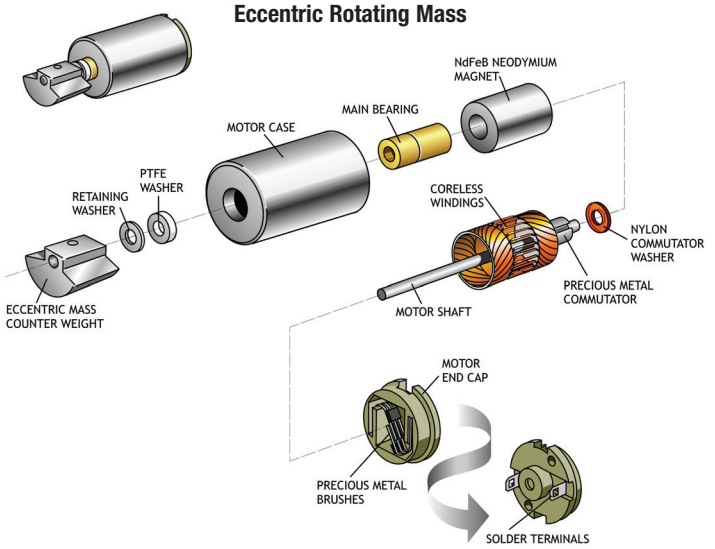
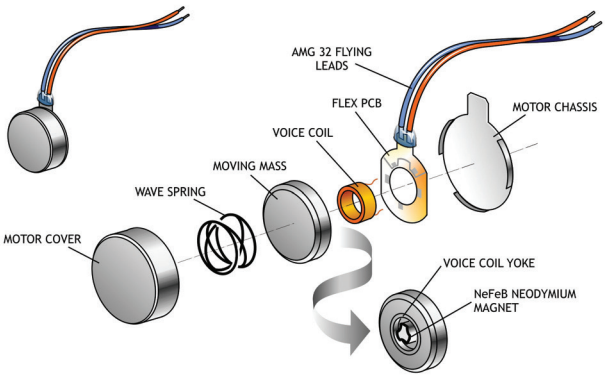
ERM vs LRA

Eccentric Rotating Mass



Linear Resonant Actuator



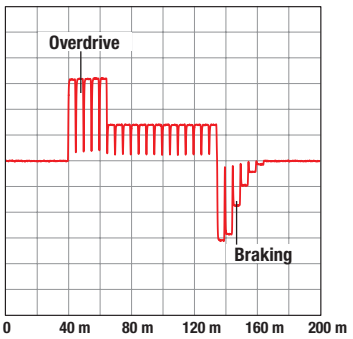
Images courtesy of Precision Microdrives

Eccentric Rotating Mass
- Drive: DC, 1 V - 5 V
- Frequency and amplitude are dependent

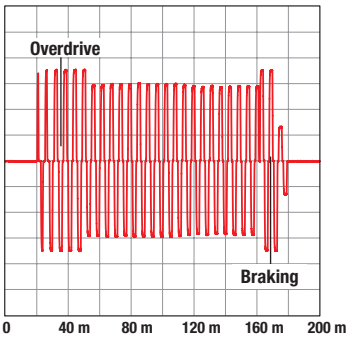
Linear Resonant Actuator
- Drive: AC, 2 Vrms
- An LRA has a resonant frequency due to the spring and mass mechanics; amplitude modulation is very easy
- Up to 2x more force and 50% less power with TI drivers

Smart Loop Architecture
- Automatic Overdrive – faster start time with controlled startup
- Automatic Braking – quicker stopping with active braking
- Automatic Level Calibration – provide consistent feel across actuators
- Actuator Diagnostics – easily check the status of the actuator

ERM Drive Waveform

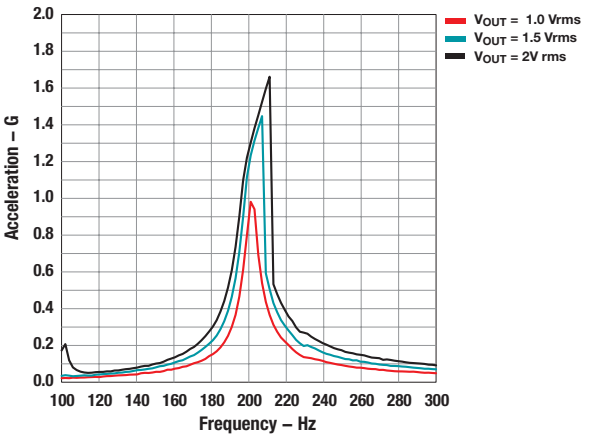


LRA Drive Waveform



Auto-Resonance
- An LRA has a narrow operating bandwidth centered around the resonant frequency
- The LRA resonant frequency will vary due to numerous external factors including mounting position and acceleration (see graph to the left)
- TI's auto-resonance eliminates the need to know the resonant frequency
- Auto-resonance tracking provide consistent and strong vibration across all actuators

Vibration Strength vs Frequency



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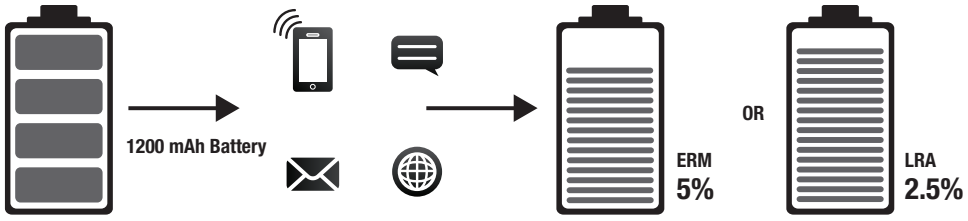
Driver Selection Table

Features	DRV2603	DRV2604	DRV2605	DRV2605 (1.8 V)
ERM and LRA Drive Modes	✔	✔	✔	✔
Drive Strength Independent of Supply	✔	✔	✔	✔
Efficient H-Bridge Driver Implementation	✔	✔	✔	✔
Automatic Input Level Translation	✔	✔	✔	✔
LRA Auto Resonance Tracking and Smart Loop	✔	✔	✔	✔
I²C Control for Device Parameters		✔	✔	✔
ERM Mode With Smart Loop		✔	✔	✔
Automatic Actuator Calibration and Diagnostic		✔	✔	✔
External Trigger Mode and Multi-Device Trigger		✔	✔	✔
Waveform RAM (2 kB)		✔		
Real-Time I²C Playback Mode		✔	✔	✔
Integrated Immersion Library			✔	✔
Audio-to-Haptics			✔	✔
1.8 V Support				✔
Package Type	QFN	WCSP	WCSP	QFN

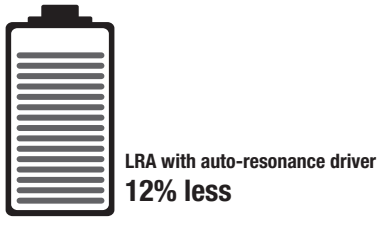
Power Consumption

Starting with a 1200 mAh smartphone battery and running a typical use case scenario of phone calls, email, messaging, and browsing the power consumption results show that an **LRA consumes less power** and is inherently more efficient than an ERM.



Effects of Auto-Resonance on Power Consumption

It was also found that an LRA consumes less power when driven intelligently by an auto-resonance driver versus a driver with static frequency control.



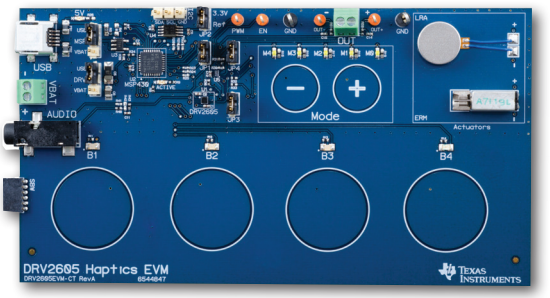
Design Resources and Reference

E2E Touch Forum
ti.com/touchforum

TI E2E™ Community

ERM & LRA Evaluation Kits - $99

- Demo or characterize the DRV2603, DRV2604, or DRV2605 using the CapSense evaluation kit
- Includes an ERM and LRA motor
- Trigger effects using the six MSP430 CapSense buttons
- Programmable MSP430 to create haptic waveforms and control the driver
- Available evaluation kits: DRV2603EVM-CT, DRV2604EVM-CT, and DRV2605EVM-CT



ERM / LRA Applications

Smartphone

- Add haptics to enhance the user interface
- Increase the performance of the existing silent alert actuators by adding haptics

Tablet / E-reader

- Add advanced UI haptics to enhance the user experience
- Add more practical feedback to the capacitive touch button home keys on Windows 8® and Android™

Accessories

- Capacitive touch mice with haptics
- Television remotes with haptics
- Laptop or free-standing mouse touch pads with haptics

See TI's complete portfolio of solutions for touch technology at ti.com/touch

- Innovative haptics products for touch-screen enabled devices
- Cool solutions for buttons, sliders, and wheels featuring MSP430
- Touch screen controllers for a broad range of performance options

Printed in U.S.A. by Almaden Press, San Jose, CA

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