OIS/AF & Haptics Solutions

Providing comprehensive Optical Image Stabilization, Auto-Focus, and Haptics solutions for smartphones, tablets, and cameras from ON Semiconductor.
Optical Image Stabilizer (OIS) Overview

1. Centers lens position during initialization
2. Gyro Sensor senses angular velocity disturbance from hand instability
3. OIS controller compensates for instability by converting angular velocity to travel distance (given as reference signal); controller moves lens with aid of actuator, and uses hall sensor to detect travel distance to feedback, so travel distance is consistent with value of gyro sensor

ON Semiconductor provides OIS drivers that are optimized for tablets, smart phones, and digital still cameras.

Actuator Mechanism

- **Lens Barrel Shift**: Shifts in direction of x-axis and y-axis
- **Lens Barrel Tilt**: Tilts within the module
- **Module Tilt**: Tilts the module itself

OIS drivers from ON Semiconductor will operate any type of actuator.
OPTICAL IMAGE STABILIZATION PORTFOLIO

**OIS Drivers**

**LC898111A**

**Unique Features**
- Built in flexible Filter
- Built in GPIO ports
- Built in OSC/LDO/Hall Amp
- Support I2C & SPI interface
- 220 mA 12-bit PWM output
- Constant Voltage Linear PWM (CVL-PWM)
- WLP package, 2.57 x 3.22 x 0.33 mm or 2.57 x 3.22 x 0.69 mm

**Other Features**
- Saturation-drive H-Bridge 2-channel (220 mA)
- Built in ADC 12-bit 5-channel/DAC 8-bit 2-channel
- Digital Gyro I/F
- External Clock input is possible
- Supply voltage
  - Digital/logic: 2.6 V to 3.6 V
  - Analog: 2.6 V to 3.6 V
  - Driver: 2.6 V to 3.6 V

**Benefits**
- Easy filter design using filter calculation tools
- Reduced number of external components
- PWM drive lowers power consumption
- Noise reduction through CVL-PWM

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<tr>
<th>Device</th>
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<td>LC898111AXB*</td>
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* Pending 2H13

**LC898119**

**Unique Features**
- Built in flexible Filter
- Built in GPIO ports
- Built in OSC/LDO/Hall Amp
- 220 mA 12-bit PWM output
- Constant Voltage Linear PWM (CVL-PWM)
- WLP package, 2.0 x 2.0 x 0.33 mm

**Other Features**
- Saturation-drive H-Bridge 2-channel (220 mA)
- Built in ADC 12-bit 2-channel/DAC 8-bit 2-channel
- Digital Gyro I/F
- Supply voltage
  - Analog/logic: 2.6 V to 3.6 V
  - IO: 1.62 V to 1.98 V
  - Driver: 2.6 V to 3.6 V

**Benefits**
- Easy filter design using filter calculation tools
- Reduced number of external components
- PWM drive lowers power consumption
- Noise reduction through CVL-PWM

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* Block Diagram*
OIS & AF Driver
LC898122

Unique Features
- Built in flexible Filter
- Built in GPIO ports
- Built in OSC/LDO/Hall Amp
- 220 mA 12-bit PWM output
- 150 mA 10-bit constant current
- Constant Voltage Linear PWM (CVL-PWM)
- WLP package, 2.0 x 2.6 x 0.45 mm

Other Features
- Saturation-drive H-Bridge 2-channel for OIS (220 mA)
- Saturation-driver H-Bridge/constant current 1-channel for Open/Closed AF (150 mA)
- Built in ADC 12-bit 4-channel/DAC 8-bit 3-channel
- Digital Gyro I/F
- Supply voltage
  - I/O: 2.6 V to 3.6 V
  - Analog/logic: 2.6 V to 3.6 V
  - Driver: 2.6 V to 3.6 V

Benefits
- Easy filter design using filter calculation tools
- Reduced number of external components
- PWM drive lowers power consumption
- Noise reduction through CVL-PWM

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* Pending 2H13

Block Diagram
Auto-Focus (AF) Overview

### Difference Between OIS and Closed-Loop AF

Both systems use feedback control, which requires a hall sensor for position detection. The difference is what target is used as a reference by the loop. For OIS, the target is a change in angle signaled from the gyro filter, namely the travel distance; it moves the lens in the directions of the X and Y axis, accordingly. For CL-AF, the target is a change in position in the direction of the Z axis, signaled from ISP.

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**ON Semiconductor**

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**CLOSED-LOOP AUTO-FOCUS PORTFOLIO**

**LC898212**

**Unique Features**
- Built in equalizer circuit
- I2C Interface (1.8 V)
- Constant Voltage Linear PWM (CVL-PWM)
- Built in ADC 10-bit 2-channel/DAC 8-bit 2-channel
- 130 mA 12-bit PWM output
- Supply voltage (2.6 V to 3.6 V)

**Other Features**
- H-Bridge 1-channel (130 mA)
- Built in OSC/LDO/Hall Amp
- Package: WLP-12, 1.37 x 1.77 x 0.69 or 0.33 mm

**Benefits**
- Easy filter design using filter calculation tools
- PWM drive lowers power consumption
- Improved PWM method reduces noise
- Closed loop architecture increases speed and accuracy of auto focus control

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**Block Diagram**

**LC898213**

**Unique Features**
- Built in equalizer circuit
- Built in Hall sensor
- I2C Interface (1.8 V)
- Constant Voltage Linear PWM (CVL-PWM)
- Built in ADC 10-bit 2-channel/DAC 8-bit 2-channel
- 130 mA 12-bit PWM output
- Supply voltage (2.6 V to 3.6 V)

**Other Features**
- H-Bridge 1-channel (130 mA)
- Built in OSC/LDO/Hall Amp
- Package: WLP-11, 1.1 x 2.2 x 0.45 mm

**Benefits**
- Easy filter design using filter calculation tools
- PWM drive lowers power consumption
- Improved PWM method reduces noise
- Closed loop architecture increases speed and accuracy of auto focus control

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* Pending 2H13
OPEN-LOOP AUTO-FOCUS PORTFOLIO

PWM AF Driver
LC898215

Unique Features
- Fast Settling Time circuit
- I2C Interface (1.8 V)
- 100 mA 10-bit PWM output
- Low power consumption by highly effective drive
- Various PWM carrier frequency is selectable
- Use driver as half-bridge or H-bridge
- Supply voltage (2.6 V to 3.6 V)

Other Features
- H-Bridge 1-channel (130 mA)
- Built in 40 MHz OSC
- Package: WLP-6, 1.29 x 0.80 x 0.33 mm

Benefits
- Easy control: set target position to move
- PWM drive lowers power consumption
- Improved PWM method reduces noise
- Fast Settling Time circuit increases speed of auto focus control

PWM/Linear AF Driver
LC898216

Unique Features
- Enhanced Fast Settling Time circuit
- I2C Interface (1.8 V)
- 100 mA 10-bit selectable driver PWM/Linear
- Improved PWM output
- Various PWM carrier frequencies are selectable
- Supply voltage (2.6 V to 3.6 V)

Other Features
- Half-Bridge 1-channel (100 mA)
- Built in 40 MHz OSC
- Package: WLP-5, 1.02 x 0.72 x 0.33 mm

Benefits
- Easy control: set target position to move
- PWM drive lowers power consumption
- Improved PWM method reduces noise
- Enhanced Fast Settling Time circuit increases speed of auto focus control

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* Pending 2Q13

Block Diagram
CUSTOMER SUPPORT

Customer Support and Experience

Expertise
- Over 100 successful designs for OIS
- Shipped more than 17 million units in 2012 for OIS
- ON Semiconductor collaborates closely with key suppliers of gyro sensors, actuators, and cameral modules

People
- Highly skilled FAE team provides global support
- Feedback provided based on actuator characteristics of specific design

Tools
- Filter calculation tool (FC) checks the frequency response of servo filter

HAPTICS

Various Vibrators for Mobile Phones

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Intensity | Strong | Strong | Weak
Thickness | Thin | Thick | Thin
Response | Quick | Slow | Slow
Rate of Power | Around 0.7 | 1 | Around 0.9

Linear vibrators are excellent on all aspects including intensity, thickness, response, and power. For this reason, linear vibrators (LRA) are most widely used for smartphones and tablets. ON Semiconductor also supplies motor drivers that are suitable for LRAs.
Linear Vibrator Drivers

**LC898300**

The LC898300 is a linear vibrator driver dedicated to haptics feedback and vibrator in handheld devices. This driver adjusts automatically the driving frequency to the resonance frequency of the linear vibrator without external parts.

**Unique Features**
- Automatically adjust driving frequency (SANYO patent)
- Minimized start-up and brake period (Quick stop)
- Automatically stop braking to avert counter vibration

**Other Features**
- Supply voltage = +2.7 to +3.3 V
- I_{out max} = 150 mA
- Bridge R_{DS(on)} = 2 x 2 Ω (4 x 2 Ω MOSFETs embedded)
- No peripheral component required (only 0.1 µF cap)
- Low power consumption

**Benefits**
- High efficiency (50% less)
- Easy handling (no adjustment for any LRA)
- Strong vibration

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**LC898301**

The LC898301 is an extended supply range version of the LC898300 LRA driver, compatible with cellular battery voltage. The architecture chosen allows to get a stronger vibration in a minimal board space and cost effective solution. Moreover, the LC898301 exhibits superior vibration performance.

**Unique Features**
- Automatically adjust driving frequency (SANYO patent)
- Minimized start-up and brake period (Quick stop)
- Automatically stop braking to avert counter vibration

**Other Features**
- Supply voltage = +3.0 to +5.5 V
- I_{out max} = 200 mA
- Bridge R_{DS(on)} = 2 x 2 Ω (4 x 2 Ω MOSFETs embedded)
- No peripheral component required (only 0.1 µF cap)
- Low power consumption

**Benefits**
- High efficiency (50% less)
- Easy handling (no adjustment for any LRA)
- Strong vibration
- Fault-detection
- Battery direct supply
- Fully configurable through I2C

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<th>Device</th>
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<tr>
<td>LC898300XA</td>
<td>Linear Vibrator</td>
<td>WLP-9</td>
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* Pending 2H13
LC898300 Feature Summary

AUTOMATIC TUNE — Automatically adjusts driving frequency, free of resonance frequency

- Initial drive set $f = 181\,\text{Hz}$
- Drive pin 1
- Drive pin 2
- $f_0 = 175\,\text{Hz}$
- Measurements
- Compensate for resonance frequency spread

<No automatic tune 181Hz drive>  <Automatic tune 181 → 175 Hz drive>

- Drive pin 1
- Drive pin 2
- Acceleration sensor
- Strong Vibration

AUTOMATIC BRAKE — LC898300 automatically minimizes vibration when EN is set to “L”

- <Brake OFF>
- <Automatic Brake ON>
- Vibration level 0.9 G in 25 ms after brake
- Vibration level 0.3 G in 25 ms after brake
- Brake is very effective due to automatic tune
- Automatically stop
**LC898300 Feature Summary**

**EASY HANDLING** — Drive under best conditions with only Enable pin, free of configuration set or control pins

- Others
  - It’s need to keep a correct frequency
  - *Need to match resonance frequency*

- LC898300
  - Easy to control
  - *LC898301 has PWM-IF as well as EN pin*

**LOW POWER** — For the reason of the short time drive

- Motor Driving current
  - 87 mA at audio driver, 43 mA reducing drive current by 50%
  - Current wave at square drive
  - Current wave at SANYO drive

- No contribute to vibration power
### Sales and Design Assistance from ON Semiconductor

#### ON Semiconductor Distribution Partners

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<tr>
<th>Partner</th>
<th>Website</th>
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<tr>
<td>Allied Electronics</td>
<td><a href="http://www.alliedelec.com">www.alliedelec.com</a></td>
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<td>AMSC Co.</td>
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<td>(81) 422 54 6622</td>
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<td>Arrow Electronics</td>
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<td>Newark/Farnell</td>
<td><a href="http://www.farnell.com/sonsemi">www.farnell.com/sonsemi</a></td>
<td>(800) 4 NEWARK</td>
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<tr>
<td>Promate Electronic Co.</td>
<td><a href="http://www.promate.com.tw">www.promate.com.tw</a></td>
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#### INTERNATIONAL

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#### AMERICAS FIRMS

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<td>Huntsville</td>
<td>e-Components</td>
<td>(256) 533-2444</td>
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<tr>
<td>Brazil</td>
<td>Countrywide</td>
<td>Ammon &amp; Rizos</td>
<td>(+55) 11-4688-1960</td>
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<tr>
<td>California</td>
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<td></td>
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<td>Tech Coast Sales</td>
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