

# Linear Vibrator Driver

CMOS LSI

## LC898302AXA



WLCSP6, 0.78 x 1.18  
CASE 567KP

### Overview

LC898302AXA is a LRA (Linear Resonant Actuator) & ERM (Eccentric Rotating Mass) Driver IC dedicated to haptic feedback actuator and vibrator employed in mobile equipment. Due to the product superior technology, the drive frequency is automatically adjusted to the resonance frequency of the linear vibrator without the use of other external parts. As a result of this very effective drive, the vibration is as powerful as possible using very limited amount of energy compared to classical solutions

The drive and brake are fully configurable through the PWM-IF setting.

Finally, the original driving waveform allows you to reduce power consumption and it is useful to maintain battery lifetime.

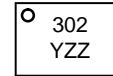
### Features

- Automatic Adjustment to the Resonance Frequency for LRA
- Automatic Braking (EN Mode Only)
- Adjustable Drive Voltage Through PWM-IF Setting
- Adjustable Brake Voltage Through PWM-IF Setting
- EN/PWM-IF Driving Mode Available by Automatic Detection
- Low Standby Current
- Low Power Consumption Thanks to the Highly Effective Drive
- Low Driving Noise (EMI, Audible Band)
- Thermal Shutdown Protection
- Available to Drive a LRA or ERM
- VBAT Compliant
- This is a Pb-Free and Halogen Free Device

### Applications

- Mobile Phone
- Portable Game
- Mobile Equipment with Haptics Function

### MARKING DIAGRAM



302 = Specific Device Code  
Y = Year  
ZZ = Lot Code

### ORDERING INFORMATION

Device	Package	Shipping†
LC898302AXA-MH	WLCSP6, 0.78 x 1.18 (Pb-Free / Halogen Free)	5000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

# LC898302AXA

## BLOCK DIAGRAM

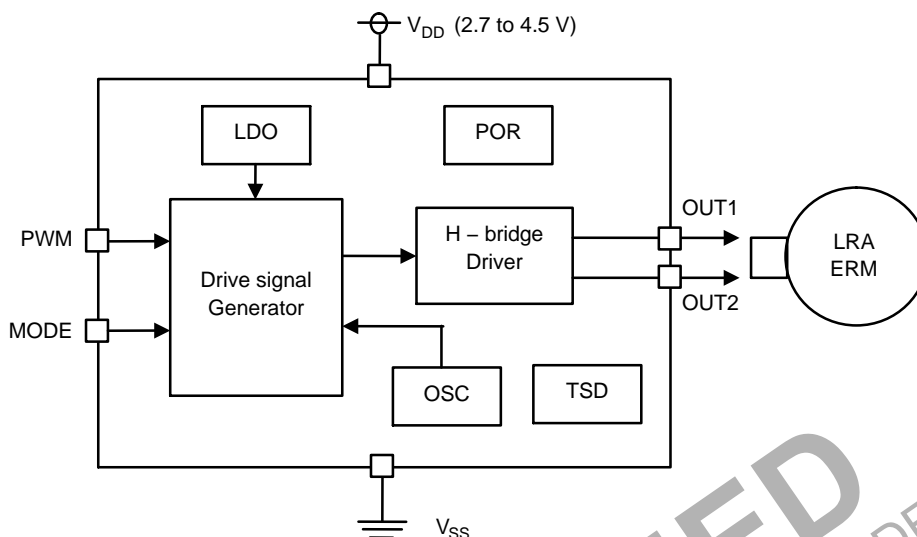


Figure 1. Block Diagram

### ABSOLUTE MAXIMUM RATINGS ( $V_{SS} = 0\text{ V}$ )

Parameter	Symbol	Condition	Rating	Unit
Supply Voltage Range	$V_{DD\text{ max}}$		-0.3 to 6.0	V
Input Voltage	$V_{I1}$	(Note 1)	-0.3 to $V_{DD} + 0.3$	V
H-bridge Drive Current	$I_{O\text{ max}}$		200	mA
Allowable Power Dissipation	$P_{d\text{ max}}$	$T_a = 85^\circ\text{C}$ (Note 2)	116	mW
Operating Temperature Range	$T_a$		-30 to 85	$^\circ\text{C}$
Storage Temperature Range	$T_{stsg}$		-55 to 125	$^\circ\text{C}$

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

- PWM, MODE pin
- Glass epoxy (50 mm x 40 mm,  $t = 0.9\text{ mm}$ , FR-4)

### RECOMMENDED OPERATING CONDITIONS ( $T_a = -30\text{ to }85^\circ\text{C}$ , $V_{CC} = 0\text{ V}$ )

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage Range	$V_{DD}$		2.7	-	4.5	V
Input Voltage Range	$V_{IN1}$	(Note 3)	0	-	$V_{DD}$	V

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

- MODE, PWM pin

# LC898302AXA

## ELECTRIC CHARACTERISTICS

### DC CHARACTERISTICS ( $V_{SS} = 0\text{ V}$ , $V_{DD} = 2.7\text{ to }4.5\text{ V}$ , $T_a = -30\text{ to }85^\circ\text{C}$ )

Parameter	Symbol	Condition	Min	Typ	Max	Unit	Applicable Pin
High Level Input Voltage	$V_{IH}$	CMOS	1.40	–	–	V	PWM
Low Level Input Voltage	$V_{IL}$		–	–	0.36	V	
High Level Input Voltage	$V_{IH}$	CMOS	$0.7 V_{DD}$	–	–	V	MODE
Low Level Input Voltage	$V_{IL}$		–	–	$0.3 V_{DD}$	V	
Input Leakage Current	$I_{IL}$	$V_I = V_{DD}, V_{SS}$	–10	–	+10	$\mu\text{A}$	PWM, MODE

### AC INPUT CHARACTERISTICS ( $V_{SS} = 0\text{ V}$ , $V_{DD} = 2.7\text{ to }4.5\text{ V}$ , $T_a = -30\text{ to }85^\circ\text{C}$ )

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input PWM Frequency	$f_{frq}$	1% < PWM Duty < 99% (Note 4)	10.0	–	50.0	kHz

4. PWM carrier frequency must be set to 128 times of resonant frequency in case of LRA mode.

### STANDBY CURRENT ( $V_{SS} = 0\text{ V}$ , $V_{DD} = 3.7\text{ V}$ , $T_a = 25^\circ\text{C}$ )

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Stand-by Current	$P_{stb}$	PWM = "0"	–	1.0	3.0	$\mu\text{A}$
Idle Current	$P_{idle}$	PWM = Duty 50%	–	2.5	–	mA

### ANALOG CHARACTERISTICS ( $V_{SS} = 0\text{ V}$ , $V_{DD} = 3.7\text{ V}$ , $T_a = 25^\circ\text{C}$ )

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Output Voltage Difference OUT1 and OUT2	$V_{OUT12}$	MODE = "0" Input PWM Duty = 99%	–	2.8	–	$V_{pp}$
		MODE = "1" Input PWM Duty = 99%	–	2.9	–	$V_{pp}$
H-Bridge ON Resistance Pch	$R_{onp}$	$I_F = 100\text{ mA}$	–	2.5	–	$\Omega$
H-Bridge ON Resistance Nch	$R_{onn}$	$I_S = 100\text{ mA}$	–	1.0	–	$\Omega$
Adjustable Resonance Frequency Range	$F_{mo}$	vs Input value	–10	–	+10	%

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

# LC898302AXA

## PIN ASSIGNMENT

### PIN LIST

No	Name	I/O	No	Name	I/O
1A	OUT1	O	1B	VDD	P
2A	OUT2	O	2B	MODE	I
3A	GND	P	3B	PWM	I

NOTE: I/O → I: input, O: output, B: bi-direction, P: power supply, NC: not connected

**Pin Layout** (PKG: WLCSP6, 0.4 mm pitch)

PWM	GND	3
MODE	OUT2	2
VDD	OUT1	1

B A  
Bottom View

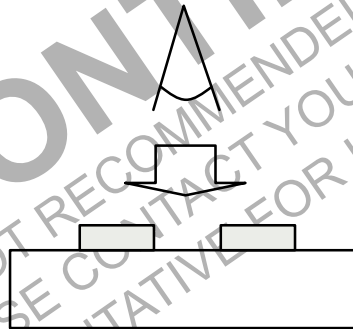


Figure 2. Pin Layout

### PIN DESCRIPTION

Signal Name	I/O	Function	Remarks
OUT1	O	Motor drive pin	H-bridge output
OUT2	O	Motor drive pin	H-bridge output
MODE	I	Motor select pin	L: LRA, H: ERM
PWM	I	Driving control pin	EN control or PWM control input
VDD	P	Power supply pin	
VSS	P	GND pin	

NOTE: I/O → I: input, O: output, B: bi-direction, P: power supply, NC: not connected

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## AC CHARACTERISTICS

**AC CHARACTERISTICS ( $V_{DD}$ )** ( $V_{SS} = 0\text{ V}$ ,  $V_{DD} = 2.7\text{ to }4.5\text{ V}$ ,  $T_a = -30\text{ to }85^\circ\text{C}$ )

Parameter	Symbol	Min	Typ	Max	Unit
$V_{DD}$ Rising Time	$T_{VDDUP}$	–	–	100	kHz

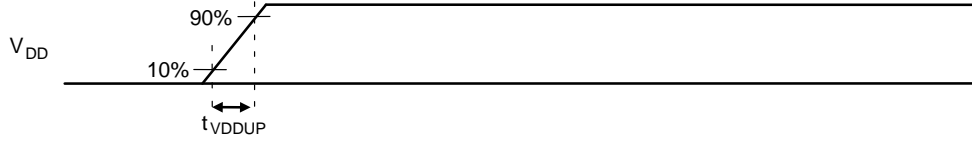


Figure 3.

**AC CHARACTERISTICS (POWER ON RESET)** ( $V_{SS} = 0\text{ V}$ ,  $V_{DD} = 2.7\text{ to }4.5\text{ V}$ ,  $T_a = -30^\circ\text{C to }+85^\circ\text{C}$ )

Parameter	Symbol	Min	Typ	Max	Unit
Start Up Time	$t_{stup}$	–	0.55	–	$\mu\text{s}$

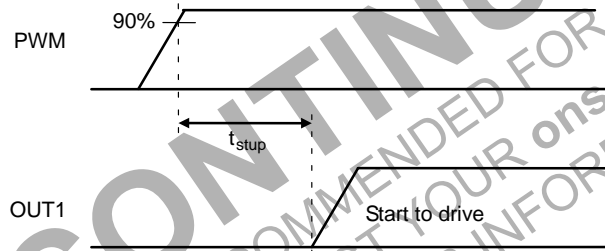


Figure 4.

DISCONTINUED

THIS DEVICE IS NOT RECOMMENDED FOR NEW DESIGN  
PLEASE CONTACT YOUR onsemi REPRESENTATIVE FOR INFORMATION

# LC898302AXA

## APPLICATION INFORMATION

### LRA Mode

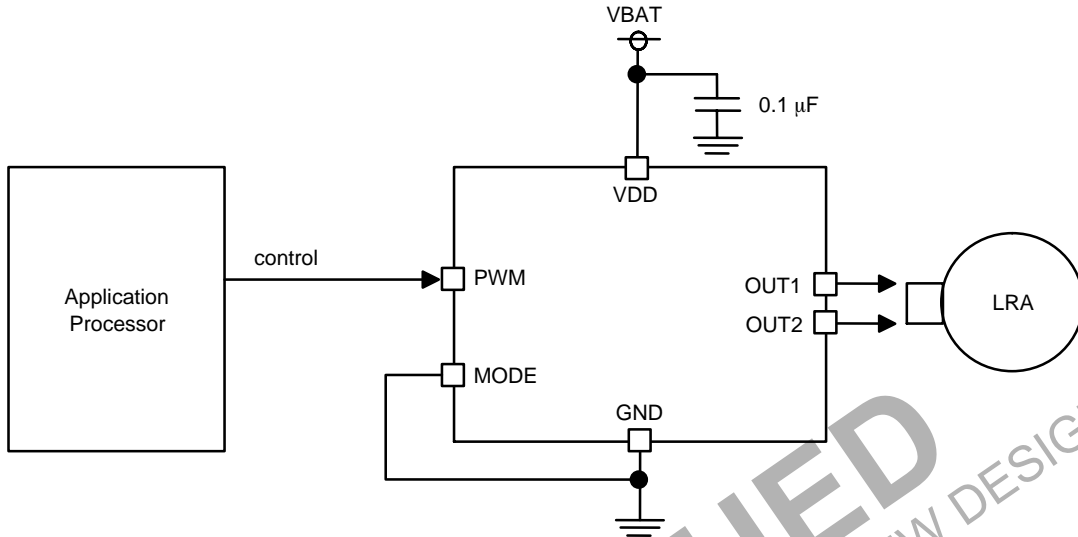


Figure 5.

### ERM Mode

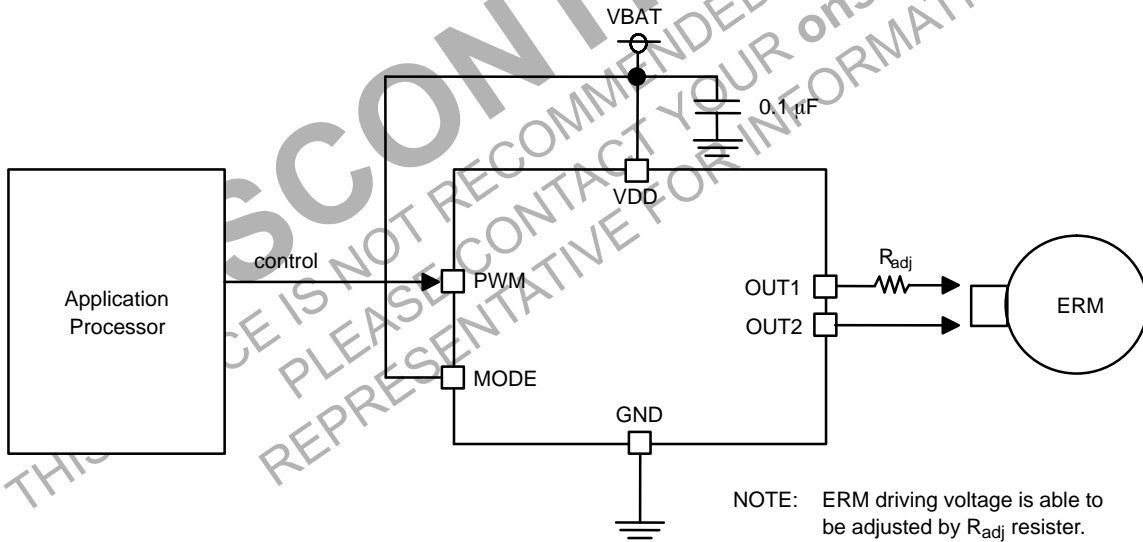


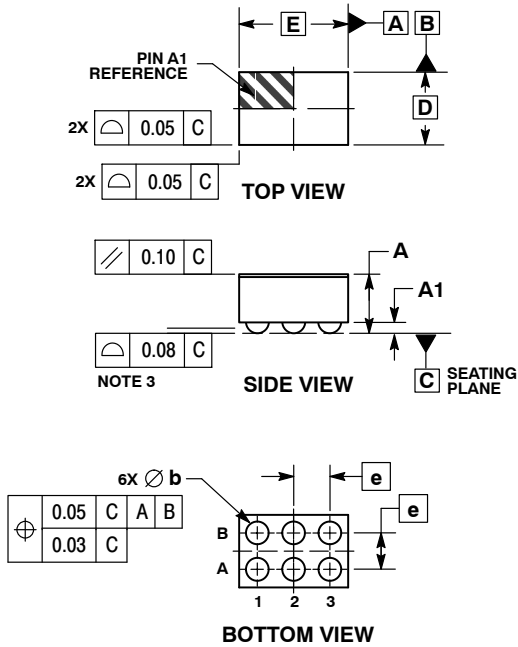
Figure 6.



SCALE 4:1

**WLCSP6, 0.78x1.18**  
CASE 567KP  
ISSUE O

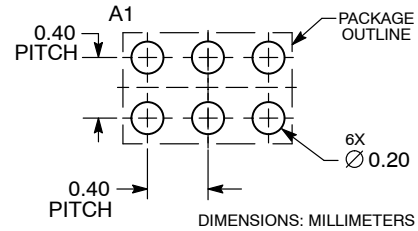
DATE 24 SEP 2014



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
  2. CONTROLLING DIMENSION: MILLIMETERS.
  3. COPLANARITY APPLIES TO SPHERICAL CROWNS OF SOLDER BALLS.

DIM	MILLIMETERS	
	MIN	MAX
A	---	0.65
A1	0.07	0.17
b	0.15	0.25
D	0.78 BSC	
E	1.18 BSC	
e	0.40 BSC	

**RECOMMENDED SOLDERING FOOTPRINT\***



\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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