



# LC898300XA

CMOS LSI

## Linear Vibrator Driver IC

ON Semiconductor®

<http://onsemi.com>

### Overview

LC898300XA is a Linear Vibrator Driver IC for a haptics and a vibrator installed in mobile equipments. The best feature is it can adjust the drive frequency to the resonance frequency of the linear vibrator automatically without external parts. As a result, the vibration power is not influenced by the difference of the resonance frequency and it is not necessary to care about the shift of resonance frequency with the lapse of time or the impact of fall. And it is possible to improve the brake performance with the automatic brake function. Moreover, it is possible to reduce the power consumption by highly effective drive.

### Functions

- Automatic adjustment to the individual resonance frequency
- Initial drive frequency adjustment function
- Various drive pattern with I<sup>2</sup>C\* IF setting (1.8V IF is available)
- Low power consumption by highly effective drive (100degree drive)
- Automatic brake function
- Drive voltage adjustment with I<sup>2</sup>C IF setting
- Low driving noise

### Applications

- Linear Vibrator (Vibration and haptics)
- Portable Game
- Mobile Phone
- Mobile equipment with haptics function

### Specifications

**Absolute Maximum Ratings** at V<sub>SS</sub> = 0V

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage range	V <sub>DD</sub> max		-0.3 to 4.6	V
Input voltage	V <sub>I1</sub>		-0.3 to V <sub>DD</sub> +0.3	V
	V <sub>I2</sub>	*1	-0.3 to 5.8	V
Output voltage	V <sub>O</sub>		-0.3 to V <sub>DD</sub> +0.3	V
H-bridge Drive current	I <sub>O</sub> max		150	mA
Allowable power dissipation	P <sub>d</sub> max	T <sub>a</sub> = 85°C *2	170	mW
Operating temperature range	T <sub>a</sub>		-30 to 85	°C
Storage temperature range	T <sub>stg</sub>		-55 to 125	°C
Input or Output current	I <sub>I</sub> , I <sub>O</sub>	*3	±20	mA

\*1: Input voltage without diode connection to V<sub>DD</sub>. (SDA, SCL)

\*2: Grass epoxy (50mm × 40mm × 0.9mm<sup>3</sup>, FR-4)

\*3: Per an I/O buffer

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

\* I<sup>2</sup>C Bus is a trademark of Philips Corporation.

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**Recommended Operating Conditions** at  $T_a = -30$  to  $85^\circ\text{C}$ ,  $V_{SS} = 0\text{V}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage range	$V_{DD}$		2.7	3.0	3.3	V
Input voltage range	$V_{IN1}$		0	-	$V_{DD}$	V

\*1: Input voltage without diode connection to  $V_{DD}$ . (SDA, SCL)

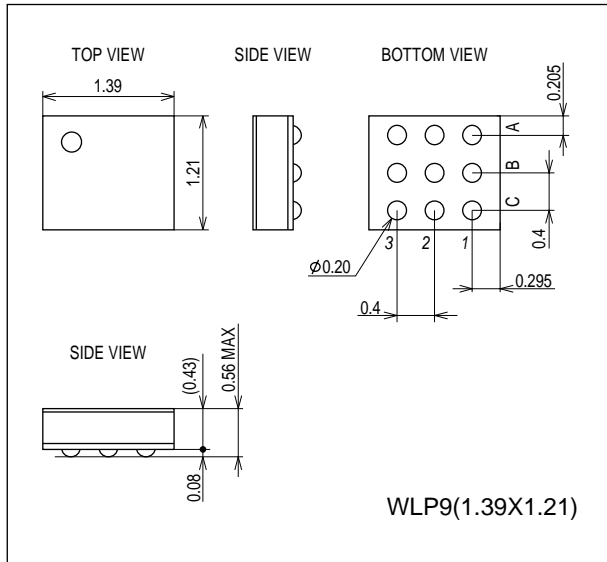
## Electrical Characteristics

Parameter	Symbol	Conditions	Applied pin	Ratings			Unit
				min	typ	max	
<b>DC characteristics</b> at $V_{SS} = 0\text{V}$ , $V_{DD} = 2.7$ to $3.3\text{V}$ , $T_a = -30$ to $85^\circ\text{C}$							
High level input voltage	$V_{IH1}$	CMOS	TEST	$0.7V_{DD}$	-	-	V
Low level input voltage	$V_{IL1}$			-	-	$0.2V_{DD}$	V
High level input voltage	$V_{IH2}$	CMOS	EN	1.5	-	-	V
Low level input voltage	$V_{IL2}$			-	-	0.36	V
High level input voltage	$V_{IH3}$	CMOS Schmitt	RSTB, SDA	1.5	-	-	V
Low level input voltage	$V_{IL3}$		, SCL	-	-	0.36	V
Low level output voltage	$V_{OL}$	$I_{OL} = 4\text{mA}$	SDA	-	-	0.4	V
Input leakage current	$I_{IL}$	$V_I = V_{DD}$ , $V_{SS}$	RSTB, EN , SDA, SCL	-10	-	+10	$\mu\text{A}$
<b>Analog characteristics</b> at $V_{SS} = 0\text{V}$ , $V_{DD} = 3\text{V}$ , $T_a = 25^\circ\text{C}$							
H-bridge ON resistance Pch	$R_{ONP}$	$I_F = 100\text{mA}$		-	2.5	-	$\Omega$
H-bridge ON resistance Nch	$R_{ONN}$	$I_S = 100\text{mA}$		-	1.5	-	$\Omega$
Adjustable resonance frequency range	$F_{mo}$	vs typ value		-10	-	+10	%

## Package Dimensions

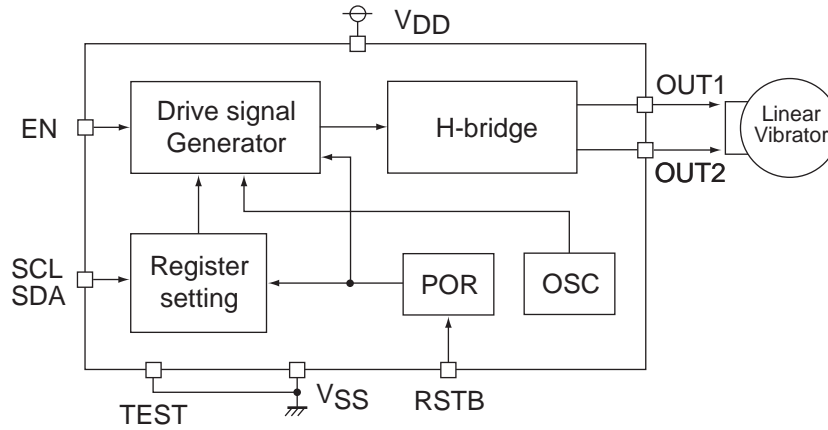
unit : mm (typ)

3429



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## Block Diagram



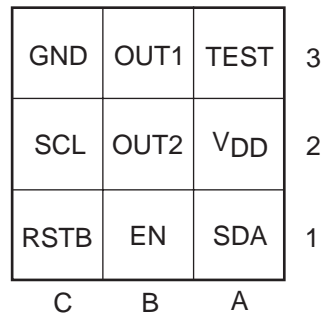
## Pin Assignment

Pin list

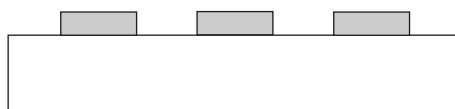
I/O ( I: input, O: output, B: bi-direction, P: power supply, NC: not connected )

No	Name	I/O	No	Name	I/O	No	Name	I/O
1A	SDA	B	1B	EN	I	1C	RSTB	I
2A	V <sub>DD</sub>	P	2B	OUT2	O	2C	SCL	I
3A	TEST	I	3B	OUT1	O	3C	GND	P

Pin layout



< Bottom View >



Pin description

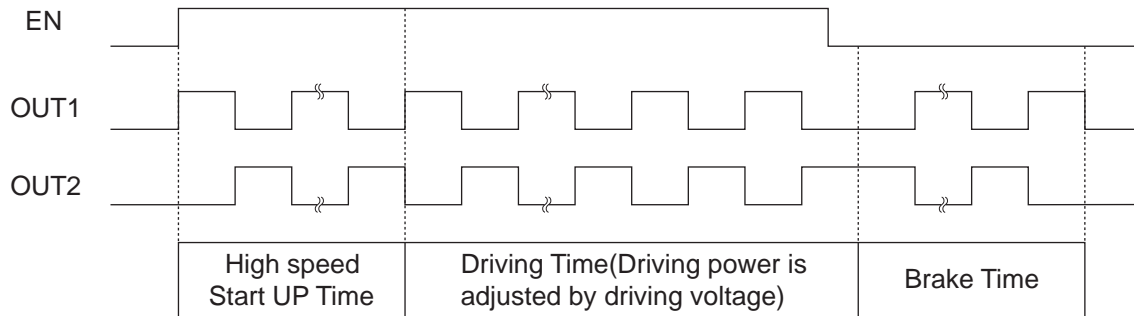
I/O ( I: input, O: output, B: bi-direction, P: power supply, NC: not connected )

Signal name	I/O	Function	Remarks
OUT1	O	Motor drive pin	H-bridge output
OUT2	O	Motor drive pin	H-bridge output
RSTB	I	Reset and standby control	L: enable, H: disable
EN	I	Motor drive ON/OFF	L: disable, H: enable
SCL	I	I <sup>2</sup> C I/F clock pin	
SDA	B	I <sup>2</sup> C I/F data pin	Open drain
TEST	I	TEST pin	L: disable, H: enable (normally Low fix)
V <sub>DD</sub>	P	Power supply pin	
V <sub>SS</sub>	P	GND pin	

## Timing chart

### Motor drive timing

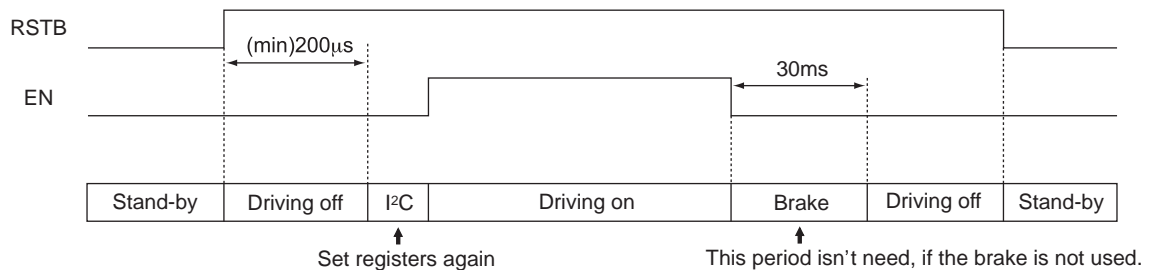
The Motor is driven by EN pin, and the driving time is controlled by keeping EN pin "H". The High speed start UP time, driving power and Brake time can be modified by I<sup>2</sup>C setting. The initial driving frequency must be set by I<sup>2</sup>C I/F at the center of resonance frequency of the linear vibrators, when the initial driving frequency is inadequate. The minimum width of EN signal must be larger than the cycle of initial driving frequency setting.



### Stand-by Control

The Stand-by mode is controlled by RSTB pin. (RSTB="L" → Stand-by mode is ON.)

When the stand-by mode is "ON", the register value is set to initial value. So, the register must be set again after the stand-by mode is "OFF". And, the "EN" signal and I<sup>2</sup>C command must wait over 200us after "RSTB" pin is set to "H".

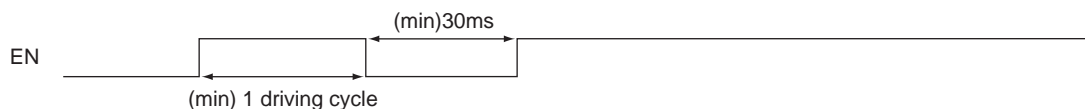


### EN Control

The width of EN=High should be set at least 1 driving cycle.

ex) 0x02 RESOFRQ=0x0A (175Hz) → (min) 5.71ms

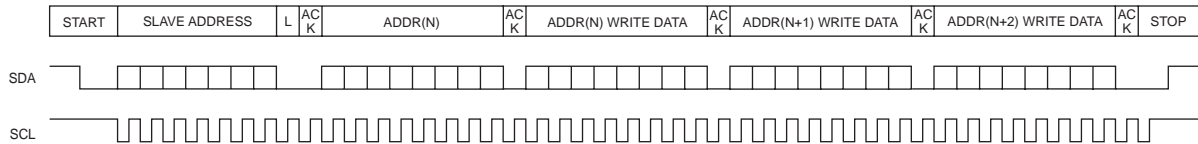
The width of EN=Low should be kept over 30ms, if the pre-driving period is over 30ms. On the other hand, If the pre-driving period is less than 30ms, the minimum width of EN=Low is same as the pre-driving width.



## I<sup>2</sup>C Serial Interface

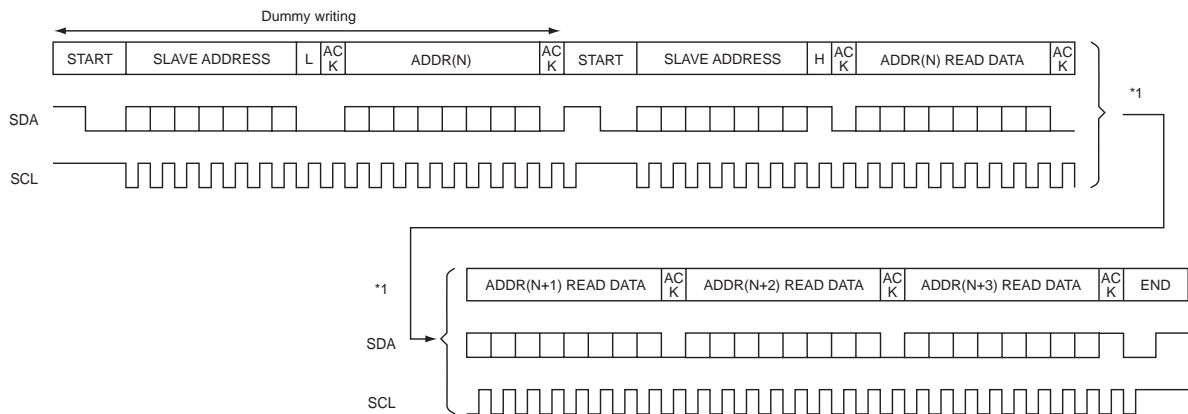
Writing format (Sequential Writing is possible)

After the start condition, slave address (7bit) and “L”(Write mode) are received , the flag “ACK=L” is replied. Next, after the 8bit address is received, the flag “ACK=L” is replied. Next, after the 8bit write data is received, the flag “ACK=L” is replied. Next, when the stop condition is received, the write data can be written in the specified address. Moreover, it is possible to write data in the incremental address by the continuous input of the 8bit data confirming the flag “ACK=L” after the every 8bit write data input.



Reading format (Sequential Reading is possible)

After the dummy writing, the start condition, slave address (7bit) and “H”(Read mode) are received, the flag “ACK=L” is replied. Next, the 8bit read data is output. After them, when the stop condition is not received, and the read condition is continued, the read data of incremental address is output one by one. The read condition is end when the end condition is received after the flag “ACK=H”.



Slave Address

The Slave Address is as follows.

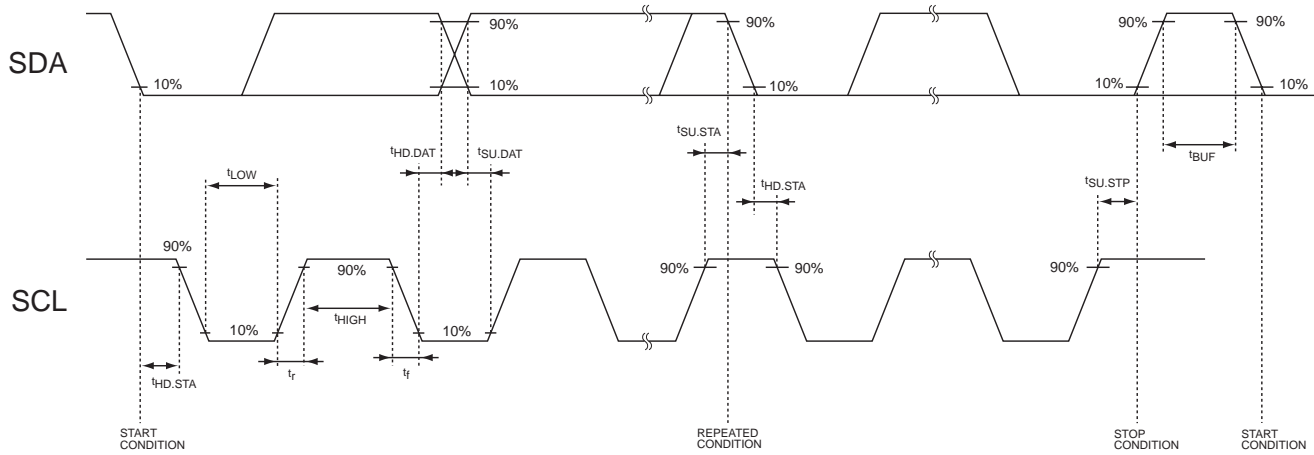
Slave Address	1001001
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AC Characteristics (I<sup>2</sup>C Serial Interface) at V<sub>SS</sub> = 0V, V<sub>DD</sub> = 2.7 to 3.3V, Ta = -30 to 85°C

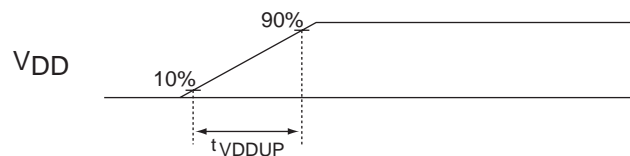
Parameter	Symbol	Pin	Min	Typ	Max	Unit	comment
SCL clock frequency	f <sub>SCL</sub>	SCL	-	-	400	kHz	
START condition Hold time	t <sub>HD,STA</sub>	SCL SDA	0.6	-	-	us	
SCL clock Low width	t <sub>LOW</sub>	SCL	1.3	-	-	us	
SCL clock High width	t <sub>HIGH</sub>	SCL	0.6	-	-	us	
RE-START condition Setup time	t <sub>SU,STA</sub>	SCL SDA	0.6	-	-	us	
SDA Hold time	t <sub>HD,DAT</sub>	SCL SDA	0	-	0.9	us	
SDA Setup time	t <sub>SU,DAT</sub>	SCL SDA	0.2	-	-	us	*1
SDA, SCL Rise time	t <sub>r</sub>	SCL SDA		-	0.3	us	*1
SDA, SCL Fall time	t <sub>f</sub>	SCL SDA		-	0.3	us	*1
STOP condition Setup time	t <sub>SU,STP</sub>	SCL SDA	0.6	-	-	us	
STOP to START BUS open time	t <sub>BUF</sub>	SCL SDA	1.3	-	-	us	

\*1) Design Assurance (Shipment test none)



AC Characteristic (Power On Reset) at V<sub>SS</sub> = 0V, V<sub>DD</sub> = 2.7 to 3.3V, Ta = -30 to 85°C

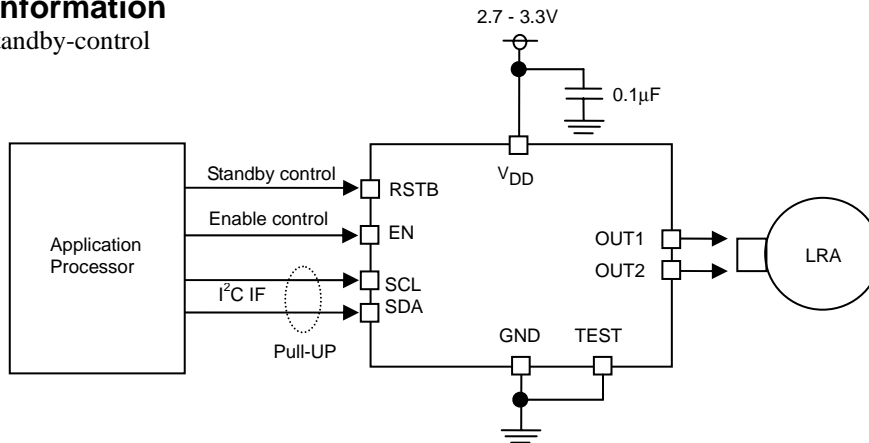
Parameter	Symbol	Min	Typ	Max	Unit	comment
V <sub>DD</sub> Rise Up Time	t <sub>VDDUP</sub>	-	-	100	ms	-



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## Application information

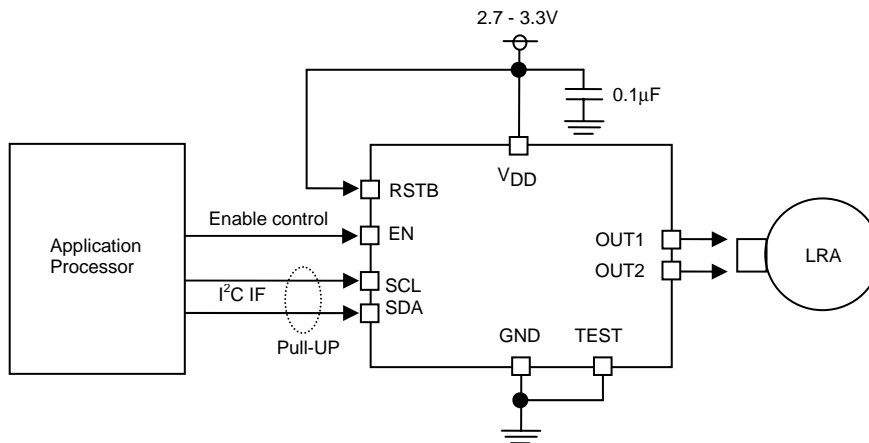
### 1) Case-1: With standby-control



Note) When SDA&SCL signal voltages are different from  $V_{DD}$ , even if the RSTB pin is set to Low, the IO leak current flows.  
ex) In case of  $V_{DD}=3.0V$  &  $SDA=SCL=1.8V$ , the current consumption is about  $100\mu A$ (typ).

### 2) Case-2: Without standby-control

Note) In case of  $V_{DD}=3.0V$ , the current consumption is about  $1.5mA$ (typ).



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