600mA, 1.3MHz Micropower Synchronous Boost Converter

General Description

The LN2240 is a synchronous, fixed frequency, step-up DC/DC converters delivering high efficiency in a 6-lead ThinSOT package. Capable of supplying 5V at 600mA from a Lithium Battery input, the devices contain an internal NMOS switch and PMOS synchronous rectifier.

A switching frequency of 1.3MHz minimizes solution footprint by allowing the use of tiny, low profile inductors and ceramic capacitors. The current mode PWM design is internally compensated, reducing external parts count. The LN2240 features automatic shifting to power saving PFM Mode operation at light loads. Antiringing control circuitry reduces EMI concerns by damping the inductor in discontinuous mode, and the devices feature low shutdown current of under 1µA.

Both devices are available in the low profile (1mm) SOT-23 package.

Features

- Up to 93% Efficiency
- 1.3MHz Fixed Frequency Switching
- Internal Synchronous Rectifier
- 2.5V to 5V Output Range
- Automatic PFM/PWM Mode Operation
- Logic Controlled Shutdown (<1µA)
- Antiringing Control Minimizes EMI
- Tiny External Components
- Low Profile (1mm) SOT-23 Package

Applications

- MP3/4 PMP
- Digital Camera
- LCD Bias Voltage
- Handheld Instruments
- Wireless Handsets
- GPS Receivers

Package

- SOT-23-6

Typical Application Circuit

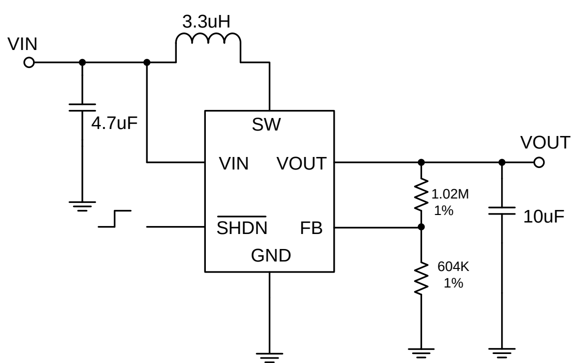


Figure1.Vout=3.3V

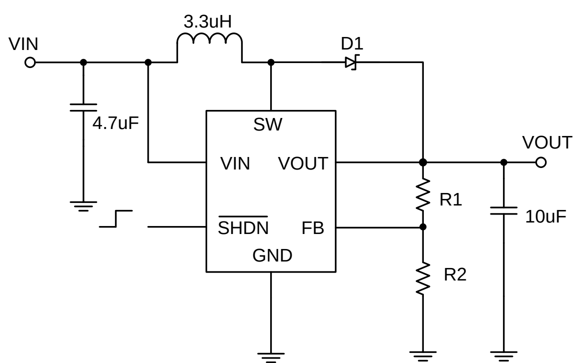


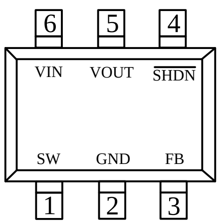
Figure 2.Vout>4.5V

■ Ordering Information

<u>LN2240 ①②③④</u>

Designator	Symbol	Description
①②	25-50/AD	Output Voltage: e.g. 33= 3.3V etc. Adjustable version: ①② fixed as AD
③	M	Package Types: SOT-23-6
④	R	Embossed Tape : Standard Feed
	S	Embossed Tape : Reverse Feed

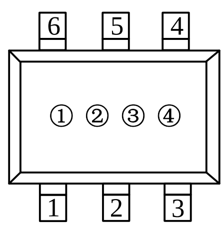
■ Functional Pin Description



SOT-23-6L
(Top View)

Pin	Name	Function
1	SW	Switch Pin.
2	GND	Ground Pin.
3	FB	Feedback Pin.
4	$\overline{\text{SHDN}}$	Chip Enable pin. Active high. Internal pull high for auto start up.
5	VOUT	Output Pin.
6	VIN	Startup input Pin.

■ Marking Rule



SOT-23-6L
(Top View)

① **Represents the product name**

Symbol	Product Name
4	LN2240◆◆◆◆

② **Represents the output voltage type**

Symbol	Represents
A	Output voltage is adjustable
F	Output voltage is fixed

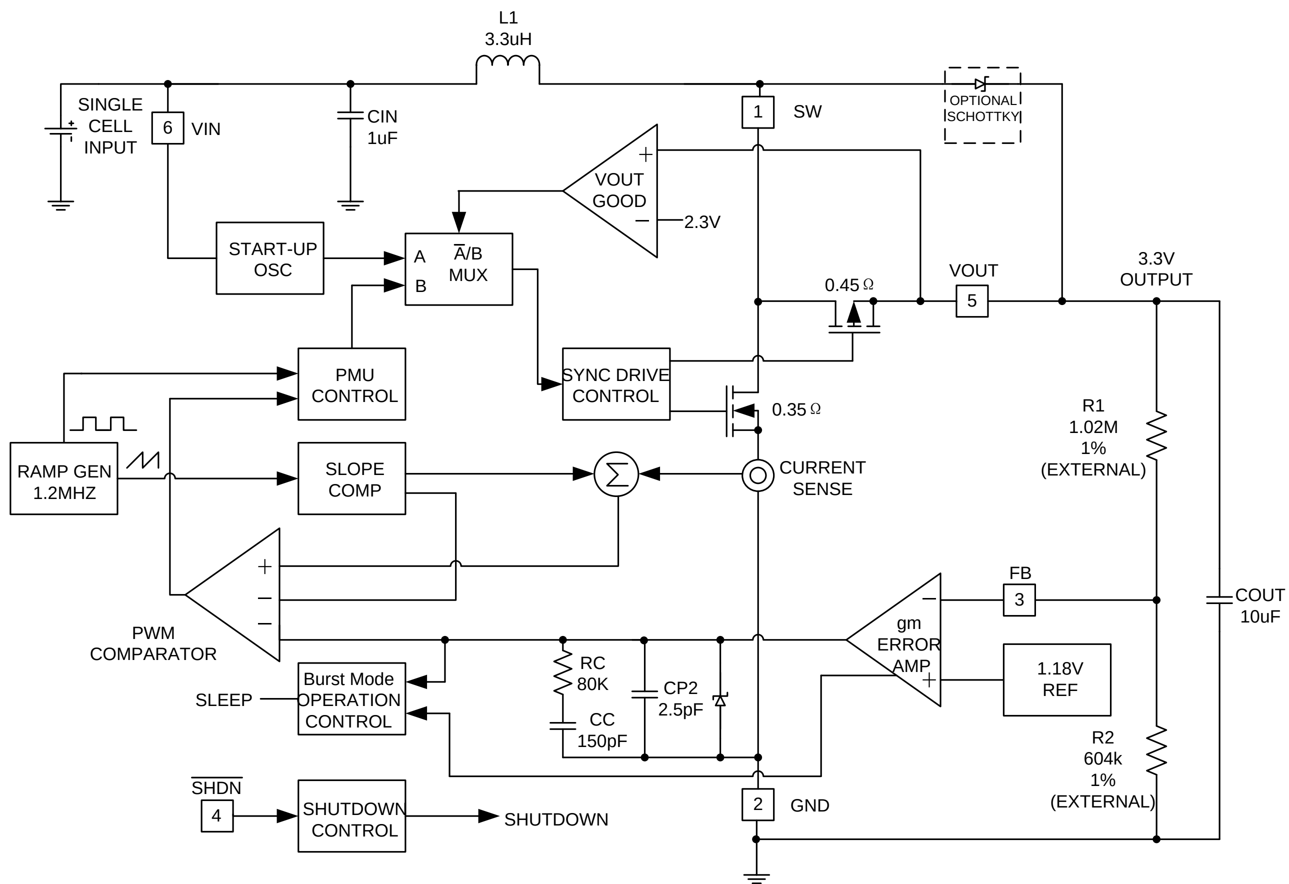
③ **Represents the package type**

Symbol	Represents
M	SOT-23-6

④ **Represents the assembly lot No.**

0-9，A-Z; 0-9，A-Z mirror writing，repeated（G，I，J，O，Q，W exception）

■ Function Block Diagram



■ Absolute Maximum Ratings

Parameter	Symbol	Maximum Rating		Unit
Input Voltage	V_{IN}	V_{SS}-0.3～V_{SS}+6		V
	V_{sw}	V_{SS}-0.3~V_{IN}+0.6		
	$V_{SHDN,FB,VOUT}$	V_{SS}-0.3～V_{IN}+0.3		
Power Dissipation	P_D	SOT-23-6	300	mW
Operating Ambient Temperature	Topr	-40～+85		°C
Storage Temperature	Tstg	-40～+125		
Reflow Temperature(soldeing,10s)	Trefl	250		°C

Electrical Characteristics

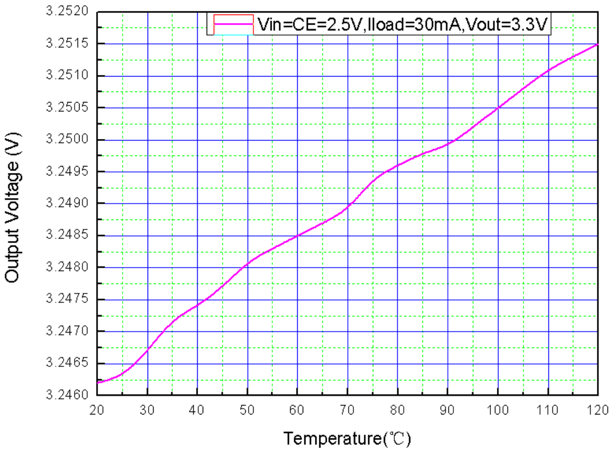
(Vin=2.5V,Vout=3.3V,TA=25℃, unless otherwise specified)

Parameter	Conditions	Min	Typ	Max	Units
Minimum Start-Up Voltage	I_{LOAD} = 1mA		1.5		V
Output Voltage Adjust Range		2.5		5	V
Feedback Voltage		1.16	1.18	1.20	V
Feedback Input Current	V_{FB} = 1.18V		1		nA
Quiescent Current (Shutdown)	$V_{/SHDN}$ = 0V, Not Including Switch Leakage		0.01	1	µA
Quiescent Current (Active)	Measured On VOUT		300	400	µA
NMOS Switch Leakage	V_{SW} = 5V		0.1	5	µA
PMOS Switch Leakage	V_{SW} = 0V		0.1	5	µA
NMOS Switch On Resistance	V_{OUT} = 3.3V		0.35		Ω
	V_{OUT} = 5.0V		0.2		Ω
PMOS Switch On Resistance	V_{OUT} = 3.3V		0.45		Ω
	V_{OUT} = 5.0V		0.3		Ω
NMOS Current Limit		1.5	2.0		A
Max Duty Cycle		75	-	85	%
Switching Frequency		1.1	1.3	1.5	MHz
/SHDN input high		0.65			V
/SHDN input low				0.5	V
/SHDN input current	$V_{/SHDN}$ = 5.5V		0.1	1	µA

■ Typical Performance Characteristics

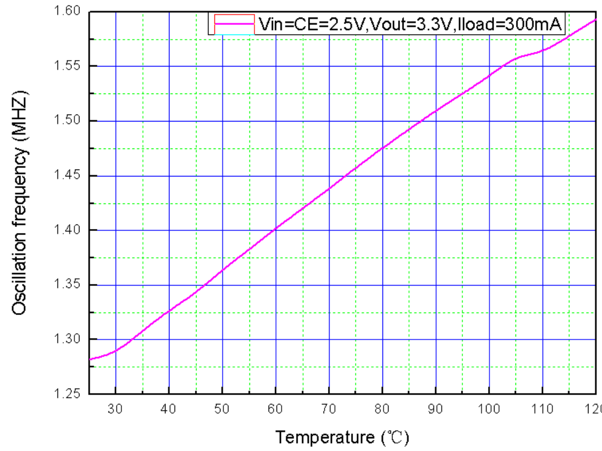
- **Vout Vs Temperature**

(Vin=SHDN=2.5V,Iload=30mA）



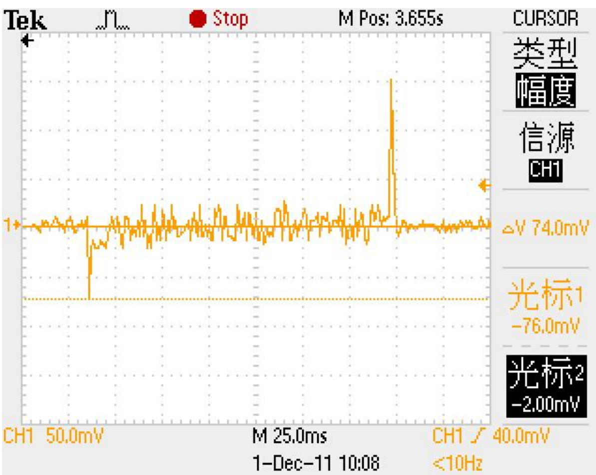
- **Oscillation Frequency VS Temperature**

(Vin=SHDN=2.5V,Iload=300mA)



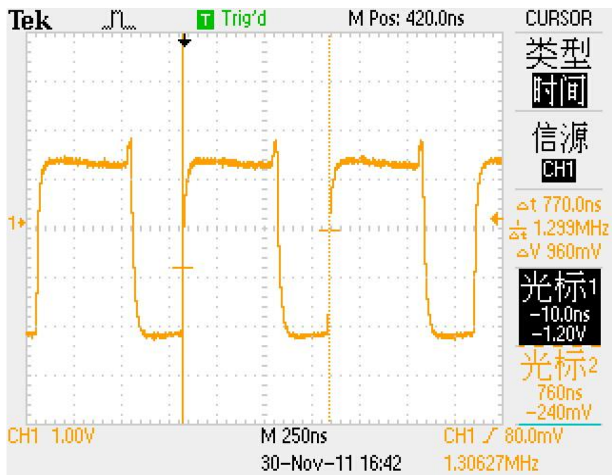
- **Load Transient Response**

(Vin=SHDN=2.5V,Vout=3.3V,Iload=0~400mA)

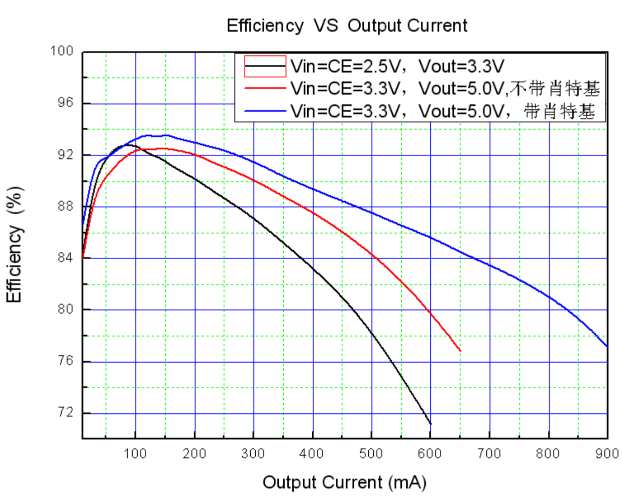


- **Wave form in PWM Mode**

(Vin=2.5V,Vout=3.3V,Iload=400mA)



- **Efficiency VS Output Current**



Operation

The LN2240 are 1.3MHz, synchronous boost converters housed in a 6-lead Thin SOT package. the devices feature fixed frequency, current mode PWM control for exceptional line and load regulation. With its low $R_{DS(ON)}$ and gate charge internal MOSFET switches, the devices maintain high efficiency over a wide range of load current. Detailed descriptions of the three distinct operating modes follow. Operation can be best understood by referring to the Block Diagram.

- **Device Enable**

The device starts to work when $\overline{\text{SHUTDOWN}}$ is higher than 0.65V. And it shuts down when $\overline{\text{SHUTDOWN}}$ is lower than 0.5V. In shutdown mode, the regulator stops switching, all internal control circuit is off and the load is disconnected from the input.

- **Error Amp**

The error amplifier is an internally compensated transconductance type amplifier. The internal 1.18V reference voltage is compared with the voltage at the FB pin to generate an error signal at the output of the error amplifier.

- **Current Sensing**

A signal representing NMOS switch current is summed with the slope compensator. The summed signal is compared to the error amplifier output to provide a peak current control command for the PWM. Peak switch current is limited to approximately 2.0 A independent of input or output voltage.

- **Zero Current Comparator**

The zero current comparator monitors the inductor current to the output and shuts off the synchronous rectifier once this current reduces to approximately 20mA. This prevents the inductor current from reversing in polarity improving efficiency at light loads.

Application Information

- **Setting the Output Voltage**

The external voltage divider from Vout to GND programs the output voltage via FB from 2.5V to 5V according to the formula:

$$Vout = 1.18V \times (1 + \frac{R1}{R2})$$

- **Setting the Inductor**

The inductor with 1.6A current rating and low DC resistance is recommended. The inductance value can be calculated from the following formula:

$$L = \frac{Vin \times (Vout - V}{Vout \times \Delta IL \times f}$$

Where ΔIL is the inductor current ripple. It is recommended the inductor current ripple to be around 30%~50% of the input current.

- **Setting the Input Capacitor**

The input capacitor (C1) is required to maintain the DC input voltage. Ceramic capacitors with low ESR/ESL types are recommended. The input voltage ripple can be estimated by:

$$\Delta Vin = \frac{Vin}{8 \times fs^2 \times L \times C1} \times (1 - \frac{Vin}{Vout})$$

Typically, a 4.7µF X7R ceramic capacitor is recommended.

- **Setting the Output Capacitor**

The output current to the step-up converter is discontinuous, therefore a capacitor is essential to supply the AC current to the load. Use low ESR capacitors for the best performance. Ceramic capacitors with X7R dielectrics are highly recommended because of their low ESR and small temperature coefficient. The output voltage ripple can be estimated by: $\Delta Vout = \frac{Vout}{C2 \times fs \times RL} \times (1 - \frac{Vi}{Vo}$ Typically, a 10µF X7R ceramic capacitor is recommended.

- **RC Snubber Circuit**

For applications with input voltages above 4.5V which could exhibit an overload or short-circuit condition, a RC Snubber circuit is required between the SW pin and GND. The recommended parameters are R3=2Ω, C5=1nF. The circuit can be seen in Figure 3.

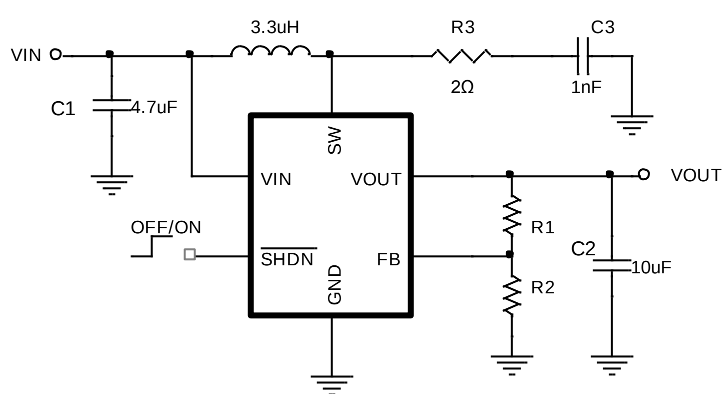
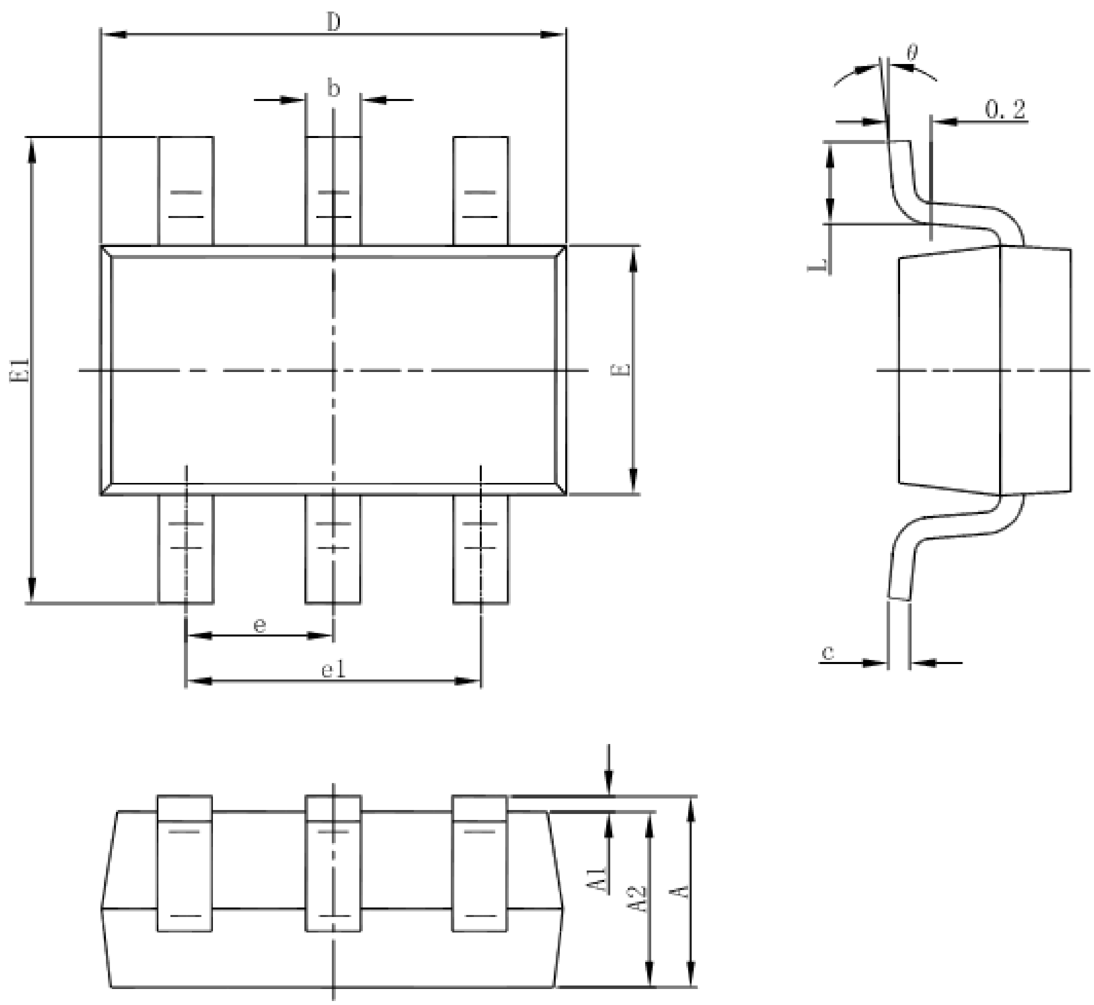


Figure 3.Vin>4.5V

■ Package Information

- **SOT-23-6**



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°