



# LC3500

0.9V startup, 1MHz, 300mA Iout, Low Iq, Synchronous Boost converter

## DESCRIPTION

The LC3500 is a step-up converter that provides a boosted output voltage from a low voltage source. Because of its proprietary design, it starts up at a very low input voltage down to 0.9V, and only consumes 15uA at standby, making it an ideal choice for single cell alkaline/NiMH battery operations.

A switching frequency of 1MHz 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.

LC3500 is available in SOT23-3, SOT23-5 and SOT89-3 Packages.

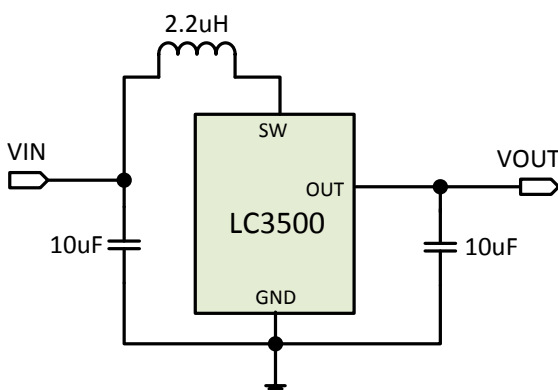
## FEATURES

- Efficiency up to 95%@Vin=2.7V, Vout=3.3V
- Typical 15uA standby current
- 1MHz Switching Frequency allows small inductor and output cap
- Input boost-strapping allows using small or no input cap
- Low Vin Start-up Voltage down to 0.9V Ideal for Single Alkaline Cell operations
- Maximum Output Current up to 300mA
- Low Noise PWM control
- Internally Compensated Current Mode Control
- Internal Synchronous Rectifier
- Available in SOT23-3, SOT23-5 and SOT89-3

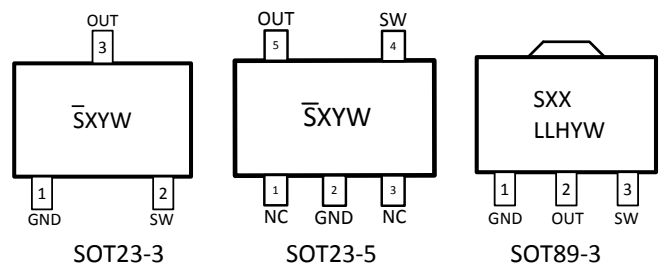
## APPLICATIONS

- One to Three Cell Battery Operated Devices
- Medical Instruments
- Bluetooth Headsets
- Flash-Based MP3 Players
- Noise Canceling Headphones

## TYPICAL APPLICATION



## PIN OUT & MARKING



S: Product Code  
X: Output Voltage  
YW: Date code

S: Product Code  
XX: Output Voltage  
LL: LOT No.  
H: FAB Code  
YW: Date code

Output Voltage Code X:

VOUT	Code	VOUT	Code
1.8V	8	3.0V	0
2.5V	5	3.3V	3
2.7V	7	3.6V	6
2.8V	8		

## ORDERING INFORMATION

PART No.	PACKAGE	Tape&Reel
LC3500CB3TR□□	SOT23-3	3000/Reel
LC3500CB5TR□□	SOT23-5	3000/Reel
LC3500CC3TR□□	SOT89-3	1000/Reel

**Note:** □□ stands for output voltage.

## ABSOLUTE MAXIMUM RATING

Parameter	Value	
SW Voltage	-0.3 ~ 6V	
OUT Voltage	-0.3 ~ 6V	
Max Operating Junction Temperature(Tj)	125°C	
Maximum Power Dissipation	SOT23-3	450mW
	SOT23-5	450mW
	SOT89-3	500mW
Ambient Temperature(Ta)	-40°C – 85°C	
Storage Temperature(Ts)	-55°C - 150°C	
Lead Temperature & Time	260°C, 10S	

**Note:** Exceed these limits to damage to the device.

Exposure to absolute maximum rating conditions may affect device reliability.

## ELECTRICAL CHARACTERISTICS

(T<sub>A</sub>=25°C)

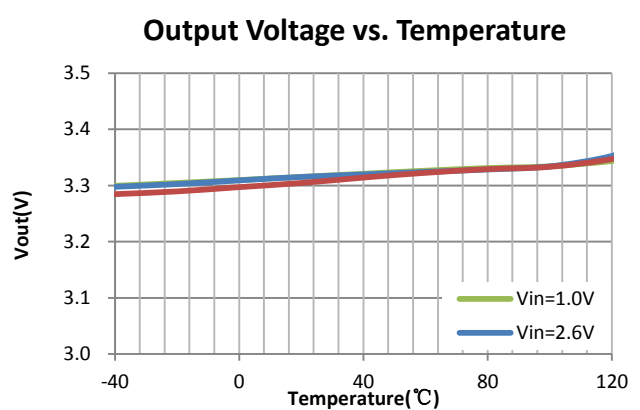
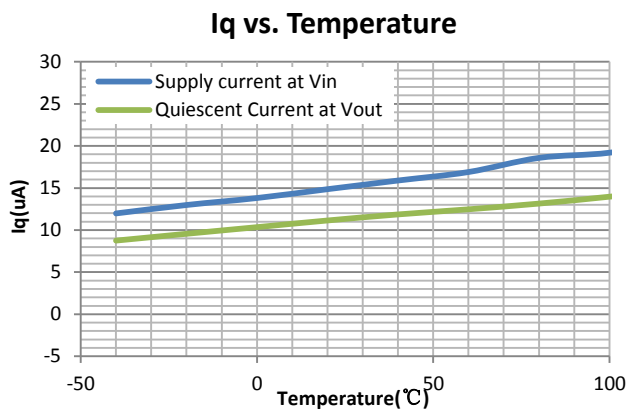
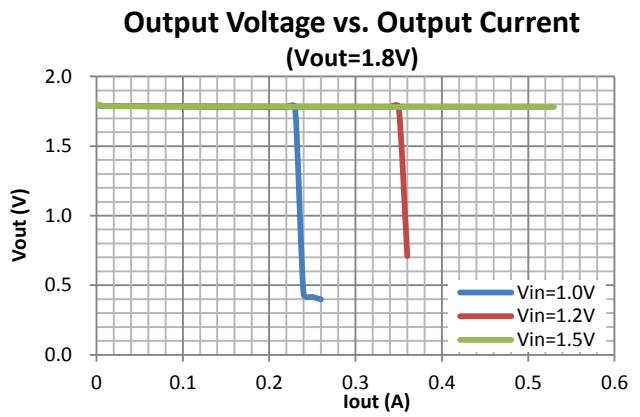
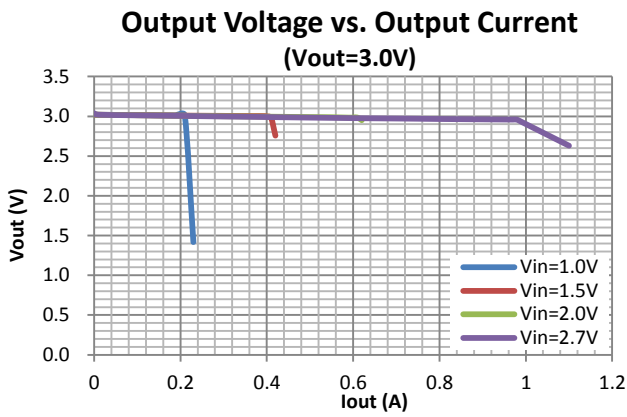
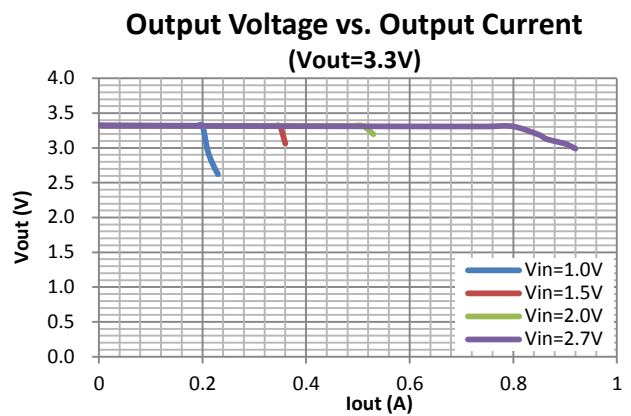
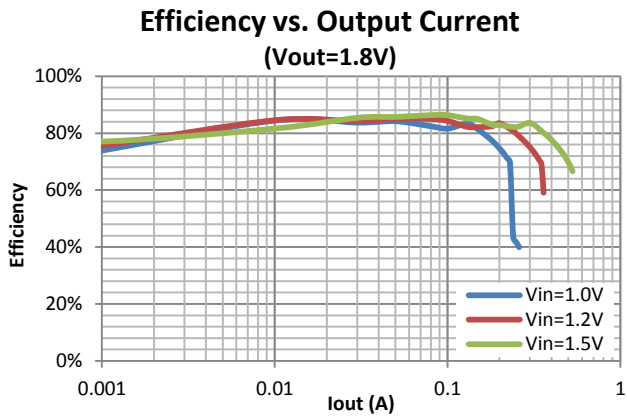
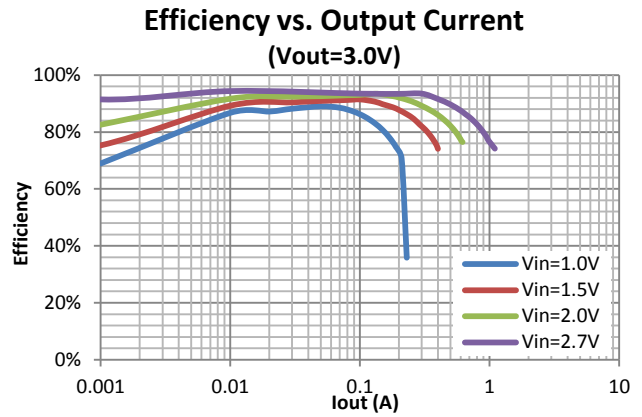
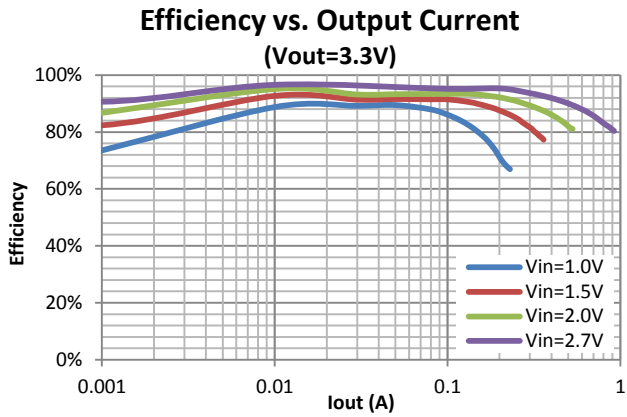
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>in</sub>	Input Voltage Range		0.9		5	V
V <sub>start</sub>	Startup Voltage	I <sub>out</sub> = 1mA		0.9		V
V <sub>hold</sub>	Hold Voltage	I <sub>out</sub> = 50mA		0.5	0.7	V
V <sub>out</sub>	Output Voltage Range		1.8		3.6	V
	Output voltage accuracy	I <sub>out</sub> = 0mA		2		%
	Line regulation	I <sub>out</sub> = 50mA		0.1	0.2	%/V
	Load regulation	I <sub>out</sub> = 0~300mA		1	2	%
F <sub>soc</sub>	Switching Frequency	V <sub>out</sub> =0.95V <sub>o</sub> , No inductor	0.7	1	1.4	MHz
	Max Duty cycle	V <sub>out</sub> =0.95V <sub>o</sub> , No inductor	85	90	95	%
I <sub>q</sub>	Quiescent Current at V <sub>out</sub>	V <sub>out</sub> =1.05*V <sub>o</sub>	5	8	15	uA
	Supply current at V <sub>in</sub>	I <sub>out</sub> = 0mA			20	uA
	Efficiency	I <sub>out</sub> = 100mA	85			%
R <sub>dsonP</sub>	PMOS R <sub>dson</sub>	I <sub>sw</sub> =100mA		400	600	mohm
R <sub>dsonN</sub>	NMOS R <sub>dson</sub>	I <sub>sw</sub> =100mA		200	300	mohm
I <sub>swlk</sub>	SW Leakage Current	V <sub>out</sub> =3.6V, V <sub>sw</sub> =0 or 5.2V			1	uA

## PIN DESCRIPTION

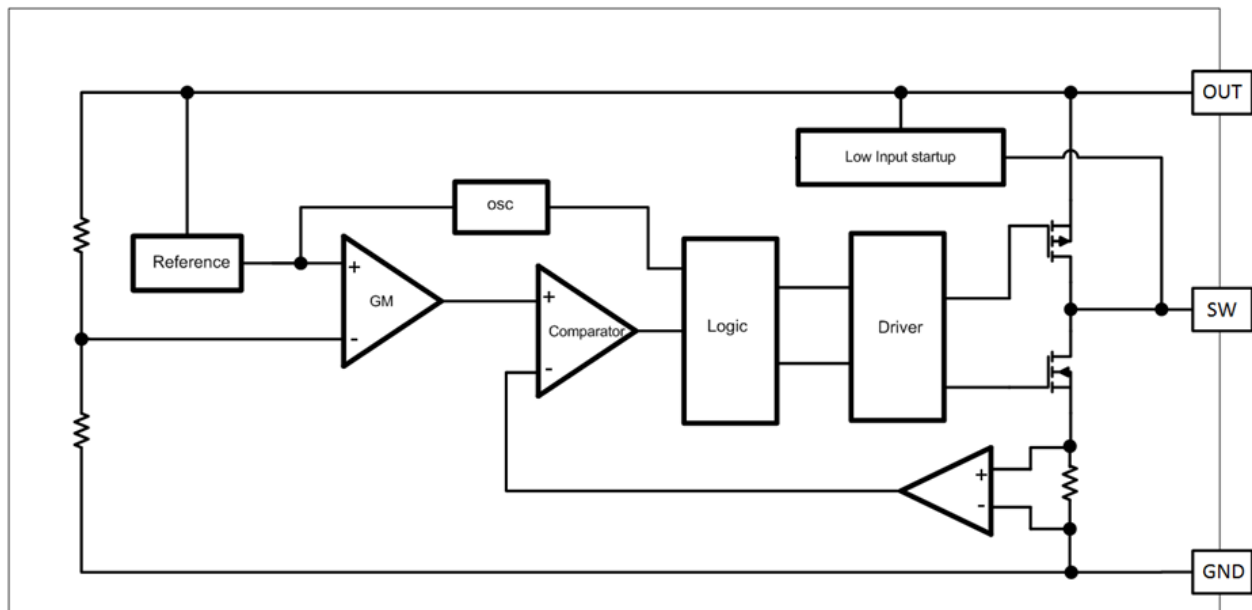
PIN #			NAME	DESCRIPTION
SOT23-3	SOT23-5	SOT89-3		
1	2	1	GND	Ground
2	4	3	SW	To connect inductor to VIN
3	5	2	OUT	Output voltage pin, with 10uF ceramic capacitor closely connected to GND
-	1, 3	-	NC	No Connection

## ELECTRICAL PERFORMANCE

Tested under  $C_{in}=C_{out}=10\mu F$ ,  $L=2.2\mu H$ ,  $T_A=25^\circ C$ , unless otherwise specified



## BLOCK DIAGRAM



## DETAILED DESCRIPTION

LC3500 is a low input voltage start up, current mode DC-DC step up converter. It's operation can be best understood by referring to the block diagram. Upon starting up, the low voltage startup circuitry drives SW with on-off cycles, transferring energy from input to OUT by storing energy in the inductor during on-time and releasing it to the output during off-time. When OUT reaches 2V, the startup circuit turns off and the main controller takes over. The main control loop consists of a reference, a GM error amplifier, a PWM controller, a current sense amplifier, an oscillator, a PWM logic control, and it is power stage including its driver. The main control loop is a classic current mode control loop. The GM stage integrates the error between FB and REF, and its output is used to compare with a triangular wave which the summing result of the current sense amplifier output and a slope compensation voltage. The output of the comparator is used to drive the power stage to reach regulation.

## APPLICATION INFORMATION

### *Inductor selection*

With switching frequency up to 1MHz, small surface mount inductors can be used with values from 2.2uH to 4.7uH. For a given chosen inductor value and application conditions make sure the peak inductor current does not exceed the maximum current rating of the selected vendor's inductor.

### *Input and output capacitor selection*

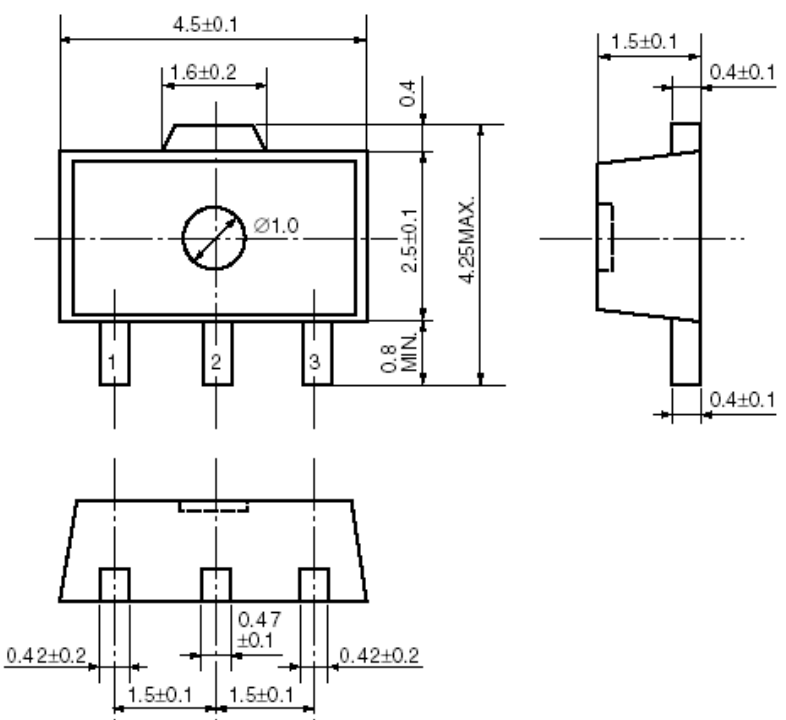
The LC3500's bootstrap architecture allows the use of very small input capacitor. For applications that only need to drive small output load current, the input capacitor is optional, because once output is started up, the IC's is powered by OUT, a quiet power supply.

The output capacitor is used to stabilize the loop and provide ac current to the load. A low ESR ceramic cap with values from 2.2uF to 22uF can be used. Smaller value capacitors are generally cheaper with small footprints, while larger capacitor provides lower ripples and better transient load responses. Also, when extreme low startup voltage is needed, larger output capacitors are needed for the part to startup under heavy load condition.

## PACKAGE OUTLINE

Package	SOT-23-3	Devices per reel	3000Pcs	Unit	mm
Package dimension:					
<p>Top view dimensions: Total width <math>2.9 \pm 0.2</math>, lead width <math>0.4 \pm 0.1</math>, lead spacing <math>1.9 \pm 0.2</math> (with <math>0.95</math> spacing between leads), body width <math>1.6 \pm 0.2</math>, total height <math>2.8 \pm 0.3</math>, and lead height <math>1.6 \pm 0.2</math>.</p> <p>Side view dimensions: Maximum lead height <math>1.4 \text{ MAX.}</math>, lead height <math>1.1^{+0.2}_{-0.1}</math>, lead width <math>0.8</math>, lead thickness <math>0</math> to <math>0.1</math>, and lead bottom width <math>0.16^{+0.1}_{-0.06}</math> with a <math>0.2 \text{ MIN.}</math> lead thickness.</p>					

Package	SOT23-5	Devices per reel	3000	Unit	mm
Package specification:					
<p>Top view dimensions: Total width <math>2.9 \pm 0.2</math>, lead width <math>0.4 \pm 0.1</math>, lead spacing <math>1.9 \pm 0.2</math> (with <math>0.95</math> spacing between leads), body width <math>1.6^{+0.2}_{-0.1}</math>, total height <math>2.8 \pm 0.3</math>, and lead height <math>1.6 \pm 0.2</math>.</p> <p>Side view dimensions: Lead height <math>1.1^{+0.2}_{-0.1}</math>, lead width <math>0.8 \pm 0.1</math>, lead thickness <math>0</math> to <math>0.1</math>, and lead bottom width <math>0.15^{+0.1}_{-0.05}</math> with a <math>0.2 \text{ MIN.}</math> lead thickness.</p>					

Package	SOT-89-3	Devices per reel	1000Pcs	Unit	mm
<p>Package dimension:</p>  <p>The technical drawing illustrates the LC3500 SOT-89-3 package from three perspectives: top, side, and bottom views. The top view shows a rectangular package with a width of <math>4.5 \pm 0.1</math> mm and a length of <math>2.5 \pm 0.1</math> mm. A central circular feature has a diameter of <math>\varnothing 1.0</math> mm. Three leads are positioned at the bottom, with a minimum lead length of <math>0.8</math> mm. The distance between the centerlines of the leads is <math>1.5 \pm 0.1</math> mm. A top feature has a width of <math>1.6 \pm 0.2</math> mm and a height of <math>0.4</math> mm. The maximum height of the package is <math>4.25</math> mm. The side view shows a total height of <math>1.5 \pm 0.1</math> mm, with a top feature height of <math>0.4 \pm 0.1</math> mm and a bottom lead height of <math>0.4 \pm 0.1</math> mm. The bottom view shows a trapezoidal shape with a top width of <math>1.5 \pm 0.1</math> mm and a bottom width of <math>1.5 \pm 0.1</math> mm. The distance from the centerline to the edge of the package is <math>0.42 \pm 0.2</math> mm, and the distance between the centerlines of the leads is <math>0.47 \pm 0.1</math> mm.</p>					

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