2.5A Synchronous Buck Li-ion Charger

General Description

The LP28303A is a 2.5A Li-Ion battery charger. It utilizes a 600KHz synchronous buck converter topology to reduce power dissipation during charging. Low power dissipation and internal MOSFET allow a physically small charger that can be embedded in a wide range of handheld applications. The LP28303A includes complete charge termination circuitry, automatic recharge and ±1% 4.2V float voltage.

Battery charge current, charge timeout and end-of-charge indication parameters are set with external components. Additional features include shorted cell detection; temperature qualified charging and overvoltage protection. The LP28303A is available in a low profile ESOP8&DFN-10 (3*3mm) package.

Features

- Input voltage range 4.5V~5.5V
- Dynamic input current allocation for maximum charging rate
- 2.5A Maximum Charge Current
- No External MOSFETs and Blocking Diode Required
- Efficiency up to 90%
- Constant-Current/Constant-Voltage Operation with Thermal Regulation to Maximize Charge Rate Without Risk of Overheating
- Optional Battery Temperature Monitoring Before and During Charge Automatic Sleep Mode for Low-Power
- ESOP8 & DFN-10 package
- RoHS Compliant and 100% Lead (Pb)-Free

Order Information

LP28303A □□ □

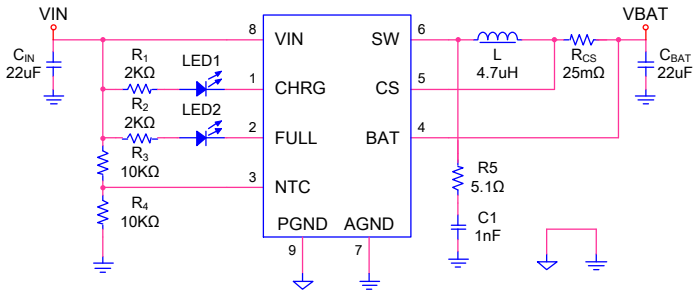
F: Pb-Free

Package Type

SP: ESOP-8

QV: DFN-10

Typical Application Circuit



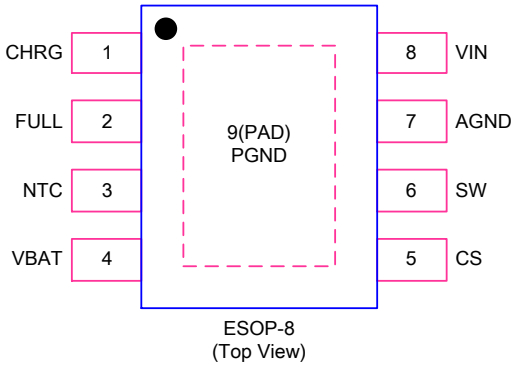
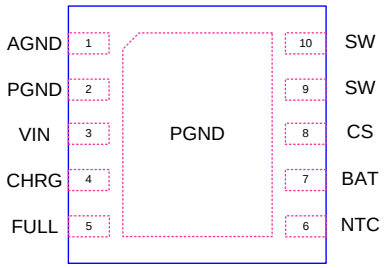
Applications

- Portable Media Players
- Cellular and Smart mobile phone
- PDA/DSC
- Handheld Battery-Powered Devices
- Handheld Computers
- Charging Docks and Cradles

Marking Information

Device	Marking	Package	Shipping
LP28303ASPF	LPS	ESOP8	4K/REEL
LP28303AQVF	LP28303A	DFN10	5K/REEL
	YWXXX		
Marking indication: Y:Production year W:Production week X: Series Number			

Functional Pin Description

Package Type	ESOP8	DFN-10
Pin Configurations	 ESOP-8 (Top View)	 DFN-10 TOP VIEW

Pin Description

Pin No.		Name	Description
ESOP8	DFN-10		
1	4	CHRG	Open-Drain charge status output. When the battery is charging, this pin is pulled low by an internal N-channel MOSFET.
2	5	FULL	Open-Drain charge status output. When charging is complete, this pin is pulled low by an internal N-channel MOSFET.
3	6	NTC	Negative Temperature Coefficient Thermistor Input. This pin senses the temperature of the battery pack and stops the charger when the temperature is out of range. Connect to GND for disabling this function.
4	7	VBAT	Battery pin.
5	8	CS	Current Sense pin.
6	9/10	SW	Switch pin. Connect to external inductor.
7	1	AGND	Analog (signal) Ground
8	3	VIN	Positive Supply Voltage Input. Decouple with a 10μF or larger surface mounted ceramic capacitor.
9(PAD)	2	PGND	Power Ground.

Absolute Maximum Ratings Note 1

- ✧ VIN pin to GND ---------- 7V
- ✧ VBAT pin to GND ---------- 7V
- ✧ Other pin to GND ---------- 7V
- ✧ Maximum Junction Temperature ---------- 150℃
- ✧ Maximum Soldering Temperature (at leads, 10 sec) ---------- 260℃

Note 1. Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Thermal Information

- ✧ Maximum Power Dissipation (ESOP8, P_D, T_A=25℃) ---------- 2W
- ✧ Thermal Resistance (ESOP8, θ_{JA}) ---------- 50℃/W

Recommended Operating Conditions

- ✧ Ambient Temperature Range ---------- -20℃ to 85℃

ESD Susceptibility

- ✧ HBM(Human Body Mode) ---------- 2KV
- ✧ MM(Machine Mode) ---------- 200V

Electrical Characteristics

(The specifications which apply over the full operating temperature range, otherwise specifications are at T_A=25℃, V_{IN} = 5V, unless otherwise noted.)

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{IN}	Adapter/USB Voltage Range		4.5		5.5	V
I_{CC}	Input Supply Current	Standby Mode (Charge Terminated)		0.1		mA
V_{FLOAT}	Regulated Output (Float) Voltage		4.158	4.2	4.242	V
V_{CS}	Current Sense Reference Voltage (For CS to BAT)	$V_{TRIKL}<V_{BAT}<V_{FLOAT}$		50		mV
I_{BAT}	BAT Pin Current	R_{cs}=50mΩ, Current Mode		1000		mA
		R_{cs}=25mΩ, Current Mode		2000		mA
		Standby Mode		1		μA
I_{TRIKL}	Trickle Charge Current	$1V<V_{BAT}<V_{TRIKL}$, R_{CS}=50mΩ		100		mA
		V_{BAT}<1V, R_{CS}=50mΩ		20		mA
V_{TRIKL}	Trickle Charge Threshold Voltage	R_{CS}=50mΩ, V_{BAT} Rising		2.8		V
V_{TRHYS}	Trickle Charge Hysteresis Voltage	R_{CS}=50mΩ		100		mV
V_{REG}	Input Regulation Voltage			4.3		V
V_{CHRG}	CHRG Pin Output Low Voltage	I_{CHRG}=5mA			0.5	V
V_{FULL}	FULL Pin Output Low Voltage	I_{FULL}=5mA			0.5	V
ΔV_{RECHRG}	Recharge Threshold Voltage	V_{FLOAT}-V_{RECHRG}		150		mV
T_{LIM}	Junction Temperature in Constant Temperature Mode			150		℃
I_{TERM}	C/10 Terminal Current	R_{CS}=50mΩ		100		mA
UVLO	Under Voltage Lockout of V_{IN}	V_{IN} rising		4.1		V
		V_{IN} falling		3.9		V
V_{OVP}	Over Voltage Protection of V_{IN}	V_{IN} rising		6.0		V
		V_{IN} falling		5.7		V
F_{OSC}	Switch Frequency	V_{IN}=5V, Current Mode		600		KHz
V_{NTC}	Protection Threshold Voltage of V_{NTC} rising			80		%V_{IN}
	Protection Threshold Voltage of V_{NTC} falling			45		%V_{IN}
	NTC Disable Voltage				100	mV

Application Information

LP28303A is a 2.5A synchronous buck Li-Ion battery charger integrates 600KHz switching frequency and full protection functions. The charge current up to 2.5A can be programmed by using the external resistor for different portable applications and indicates the charger current information simultaneous.

In constant current mode, the charge current is set by the external sense resistor R_{CS} and an internal 50mV reference;

$$I_{BAT}=V_{cs}/R_{CS}=50mV/R_{CS}$$

When the battery voltage approaches the programmed float voltage, the charge current will start to decrease. When the current drops to 10% of the full-scale charge current, an internal comparator turns off charging is terminated

Shutdown

The LP28303A can be shut-down by pulling the NTC pin to VIN. When the NTC pin is released, the internal timer is reset and a new charge cycle starts. In shutdown, the output of the CHRG pin is high impedance. Removing the input power supply will put the charger into sleep mode. If the voltage at the VIN pin drops below (V_{BAT}+200mV) or below the UVLO level, the LP28303A goes into a low current sleep mode, reducing the battery drain current.

Input Source Qualification

After REG amplifier powers up, the LP28303A checks the current capability of the input source. The input source has to meet the V_{IN}>4.3V to enable the chip.

Automatic Recharge

Once the charge cycle is terminated, the LP28303A continuously monitors the voltage on the BAT pin using a comparator with a 1.8ms filter time ($t_{RECHARGE}$). A charge cycle restarts when the battery voltage falls below 4.05V (which corresponds to approximately 80% to 90% battery capacity). This ensures that the battery is kept at or near a fully charged condition and eliminates the need for periodic charge cycle initiations.

Inductor Selection

Operating frequency was chosen for the buck switcher in order to minimize the size of the inductor. However, take care to use inductors with low core loss at this frequency. To calculate the inductor ripple current:

$$\Delta I_L = \frac{V_{BAT} - \frac{V_{BAT}^2}{V_{IN}}}{L \times f}$$

Battery Temperature Detection

The LP28303A continuously monitors temperature by measuring the voltage between the NTC and GND pins. A negative or a positive temperature coefficient thermistor (NTC, PTC) and an external voltage divider typically develop this voltage. The LP28303A compares this voltage against its internal V_{NTC1} and V_{NTC2} thresholds to determine if charging is allowed. The temperature sensing circuit is immune to any fluctuation in V_{IN}, since both the external voltage divider and the internal thresholds (V_{NTC1} and V_{NTC2}) are referenced to V_{IN}.

The resistor values of R_1 and R_2 are calculated by the following equations:

For NTC Thermistors:

$$R_1 = \frac{R_{TL}R_{TH}(K_2 - K_1)}{(R_{TL} - R_{TH})K_1K_2}$$

$$R_2 = \frac{R_{TL}R_{TH}(K_2 - K_1)}{R_{TL}(K_1 - K_1K_2) - R_{TH}(K_2 - K_1K_2)}$$

For PTC Thermistors:

$$R_1 = \frac{R_{TL}R_{TH}(K_2 - K_1)}{(R_{TH} - R_{TL})K_1K_2}$$

$$R_2 = \frac{R_{TL}R_{TH}(K_2 - K_1)}{R_{TH}(K_1 - K_1K_2) - R_{TL}(K_2 - K_1K_2)}$$

$K_{1(VNTC1)}$=45%, $K_{2(VNTC2)}$=80%.

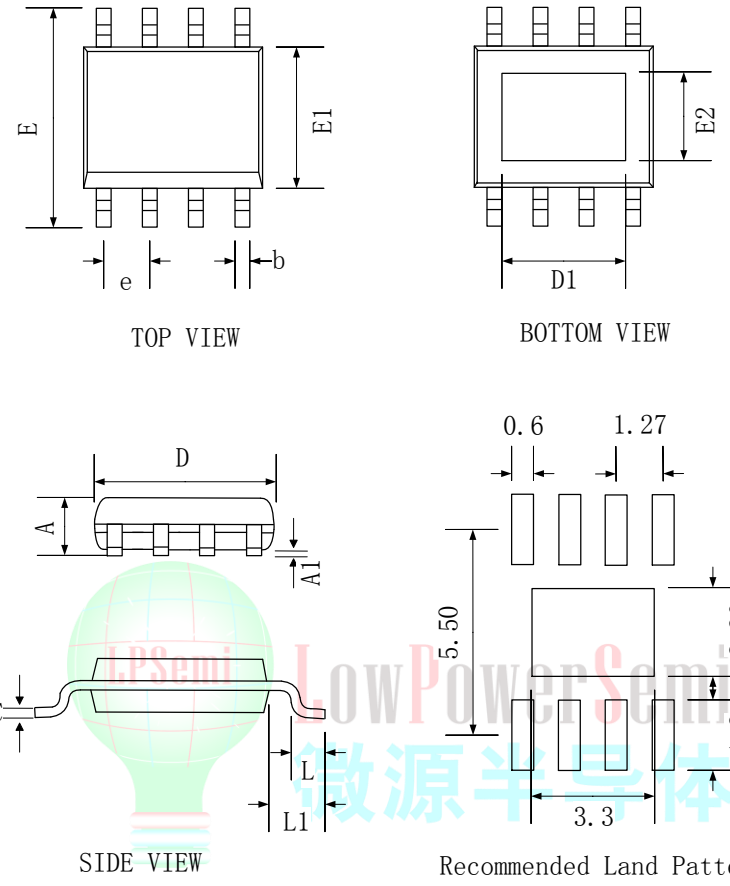
Where R_{TL} is the low temperature resistance and R_{TH} is the high temperature resistance of thermistor, as specified by the thermistor manufacturer. R_1 or R_2 can be omitted if only one temperature (low or high) setting is required. Applying a voltage between the V_{NTC1} and V_{NTC2} thresholds to pin NTC disables the temperature-sensing feature.

Layout Considerations

Switch rise and fall times are kept under 5ns for maximum efficiency. To minimize radiation, the SW pin and input bypass capacitor leads (between VIN and GND) should be kept as short as possible. A ground plane should be used under the switching circuitry to prevent inter plane coupling. The Exposed Pad must be connected to the ground plane for proper power dissipation. The other paths contain only DC and/or 600KHz tri-wave ripple current and are less critical. With the exception of the input and output filter capacitors (which should be connected to GND) all other components that return to ground should be connected to GND.

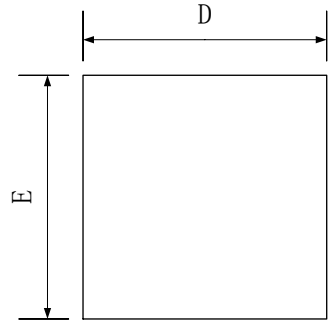
Packaging Information

ESOP8

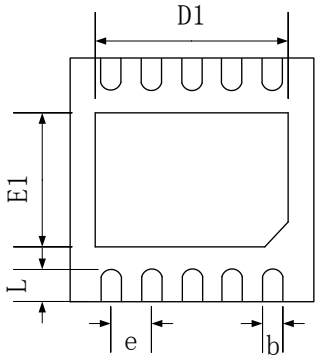


SYMBOL	Dimensions In Millimeters		
	MIN	NOM	MAX
A	1.35	-	1.75
A1	0.00	-	0.15
b	0.30	0.40	0.50
c		0.20 REF	
D	4.70	4.90	5.10
D1		3.2 REF	
E	5.70	6.00	6.30
E1	3.70	3.90	4.10
E2		2.30 REF	
e		1.27 BSC	
L	0.40	0.60	0.80
L1		1.05 REF	

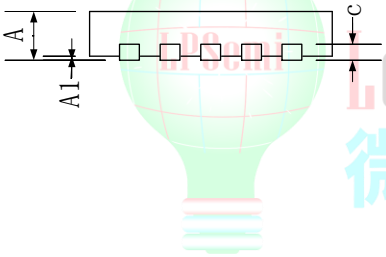
DFN-10



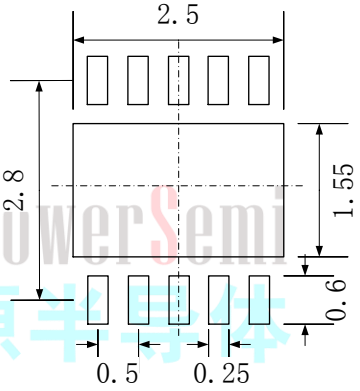
TOP VIEW



BOTTOM VIEW



SIDE VIEW



Recommended Land Pattern

SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
b	0.18	0.25	0.30
C		0.20 REF	
D	2.90	3.00	3.10
D1	2.40	2.50	2.60
E	2.90	3.00	3.10
E1	1.45	1.55	1.65
e		0.50 BSC	
L	0.30	0.40	0.50