TP5410 1000mA Li-Ion Battery Charger and 5V 1A boost

DESCRIPTION

TP5410 is a Li-Ion battery charger and 5V boost chip used for mobile power supply. High precision voltage and charge current regulator, pre-charge, charge indicator, charge circle termination and other functions are all integrated into a single chip. Maximum charge current can reach 1 A. Boost circuit uses CMOS DC/DC boost converter working in VFM switching mode, which has very low no-load current. Besides, It has limited no-load dissipation, up to 1000mA boost output current, and no external button is needed, which means it can work automatically when it is connected to supply.

No blocking diode is required due to the internal PMOSFET architecture and have prevent to negative Charge Current Circuit. Thermal feedback regulates the charge current to limit the die temperature during high power operation or high ambient temperature. The charge voltage is fixed at 4.2V, and the charge current can be programmed externally with a single resistor. The chip automatically terminates the charge cycle when the charge current drops to 1/5th the programmed value after the final float voltage is reached.

Boost output capacity reaches 5V/1A due to the internal PMOSFET architecture and limited internal resistor. TP5410 only needs a limited external devices to work properly because of integration. TP5410 other features include over temperature protection, boost input current limit circuit, boost output current adjustment, rapid reaction and over-current shut down.

FEATURES

- Programmable Charge Current Up to 1.2A, Typically1000mA
- Boost Current Up to 1.5A(Vbat=3.8V), Typically 1000mA(Vbat=3.3V)
- Specified for Mobile Power Supply with Single Li-Ion Battery
- High Boost Efficient: 88%(Typ)
- Constant Current & Constant Voltage Operation, Heat Regulating Function makes High Charge Efficient without the Danger of Overheating
- 4.2V + -1% charging voltage control Accuracy
- 5V ±2.5% boost voltage control Accuracy
- Input Voltage Up to 10V
- two Charge Status Output Pins
- C/5 Charge Termination
- 2.9V Trickle Charge Threshold
- Soft-Start Limits Inrush Current
- Automatic Frequency Adjustment (VFM), adjust to Variety Loads (No-load Current less than 10uA when Supply Voltage is 5V), No External Button is Required for Start, and Terminates Boost Circuit when Battery Voltage is Low(less than 2.7V)
- Available Radiator in 8-Lead SOP/MSOP Package, the Radiator need connect GND or impending

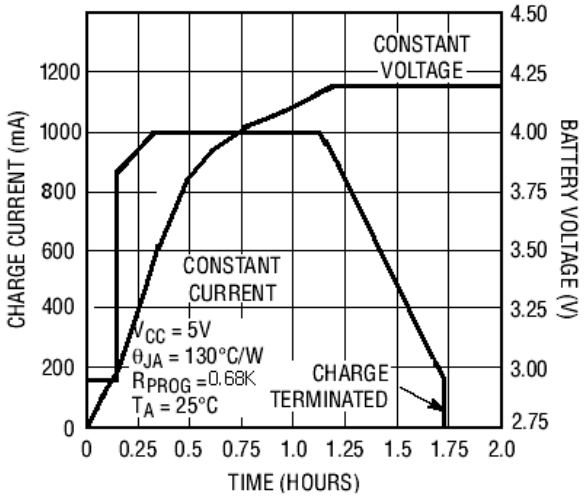
ABSOLUTE MAXIMUM RATINGS

- Input Supply Voltage(V_{CC})：-0.3V～12V
- PROG：$-0.3V \sim V_{CC}+0.3V$
- BAT：0V～7V
- LX：-2V～10V
- $\overline{VOUT}$：-0.3V～10V
- $\overline{CHRG}$：-0.3V～10V
- BAT Short-Circuit Duration：Continuous
- BAT Pin Current：1200mA
- Maximum Boost Output Current：1.8A/5V
- Maximum Junction Temperature： 145℃
- Operating Ambient Temperature Range：-40℃～85℃
- Storage temperature range:-65℃～125℃
- Lead Temp.(Soldering, 10sec)：260℃

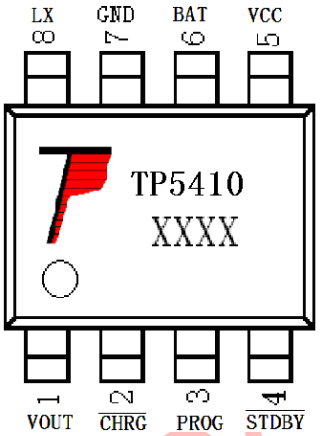
APPLICATIONS

- Mobile Power Supply

Complete Charge Cycle
(1000mAh Battery)

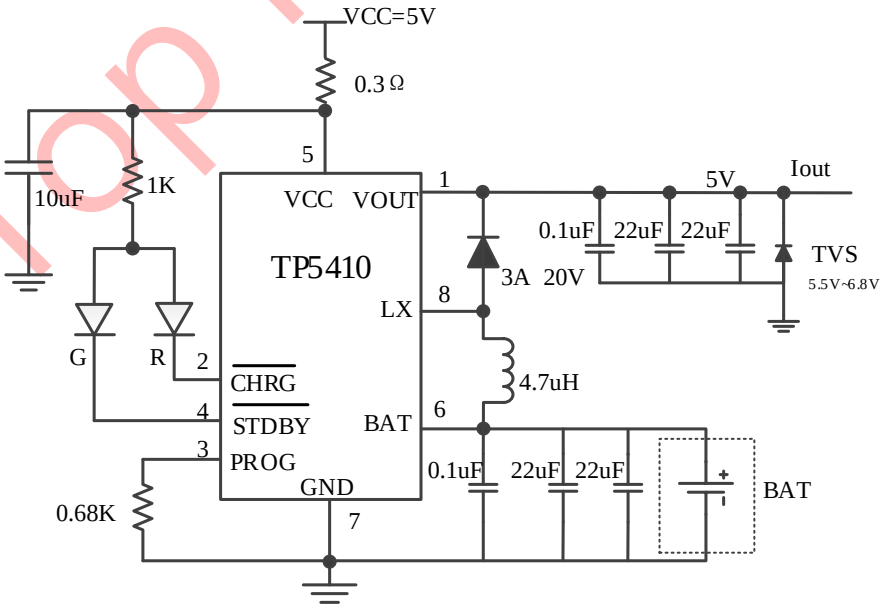


PACKAGE/ORDER

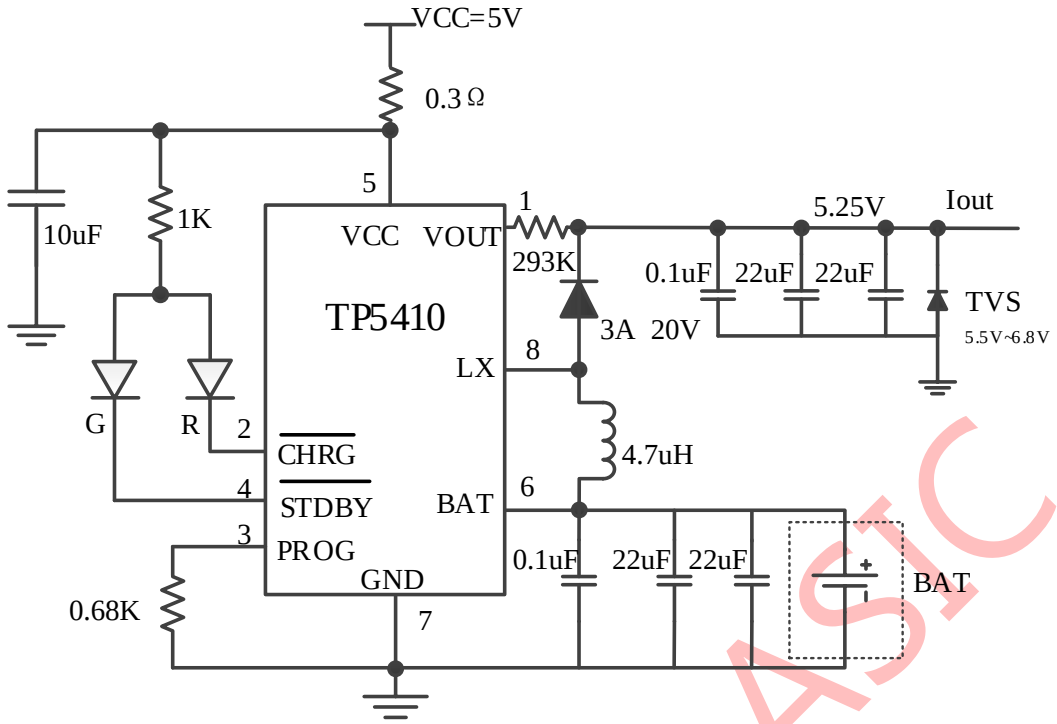


Orders Model
TP5410-ESOP8
Pictures

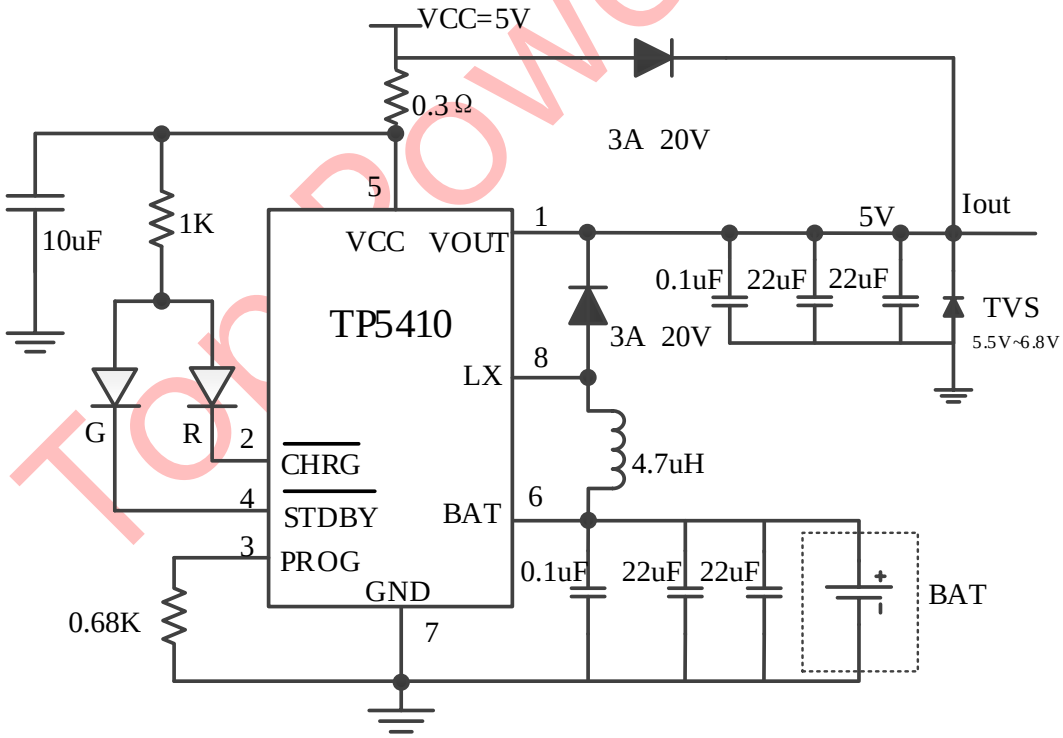

TYPICAL APPLICATIONS



1000mA Single Cell Li-Ion Charger or 5V Output Boost Converter



1000mA Single Cell Li-Ion Charger or 5.25V Output Boost Converter



1000mA Single Cell Li-Ion Charger or 5V Output Boost Converter

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at TA=25℃，VCC=5V，unless otherwise noted.

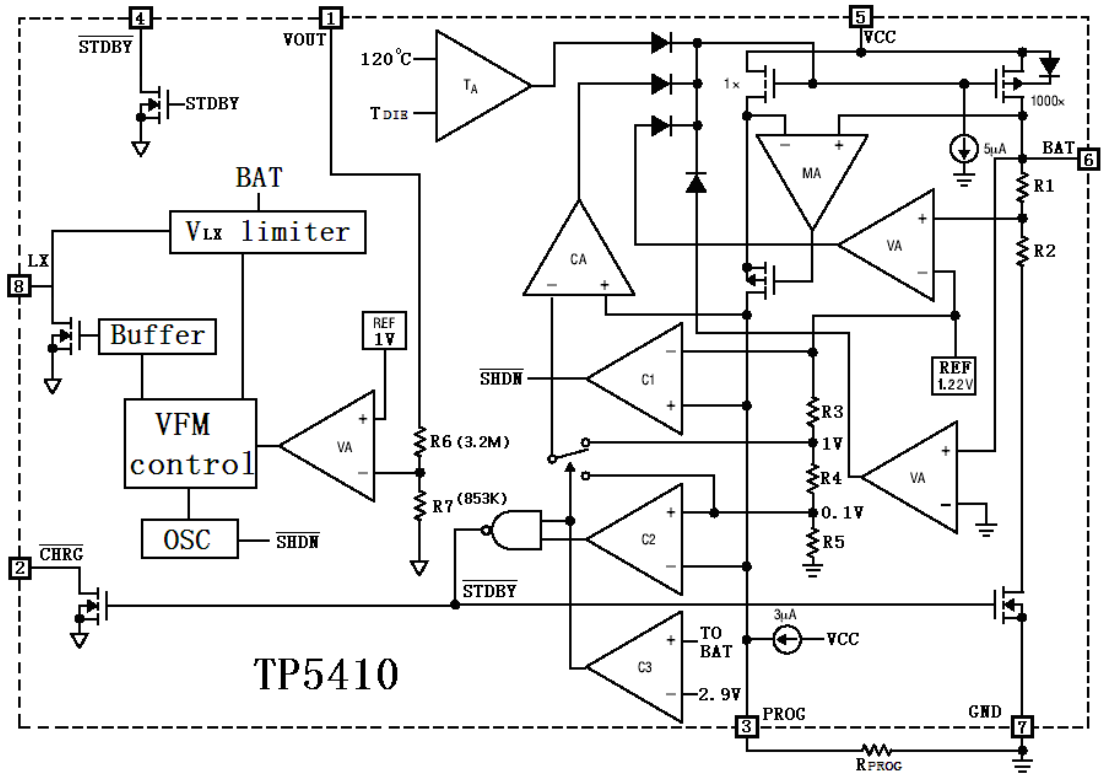
SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{CC}	Input Supply Voltage		●	4.0	5	10	V
I_{CC}	Input Supply Current	Charge Mode, R_{PROG} = 10K Standby Mode(Charge Terminated) Shutdown Mode (R_{PROG} Not Connected, $V_{CC} < V_{BAT}$, or $V_{CC} < V_{UV}$) Boost start	● ● ● 		150 60 60 60 0	500 100 100 100 	μA μA μA μA μA
V_{FLOAL}	Regulated Output (Float) Voltage	0℃≤T_A≤85℃，I_{BAT}=40mA		4.158	4.2	4.242	V
I_{BAT}	BAT Pin Current(Except for instructions，Vbat=4.0v)	R_{PROG}=1.2K，Current Mode R_{PROG}=0.68K，Current Mode Standby mode，V_{BAT}=3.8V	● ● ●	490 850 	580 1000 -10	670 1150 -100	mA mA μA
I_{TRIKL}	Trickle Charge Current	V_{BAT}<V_{TRIKL}, R_{PROG}=1.2K	●	120	130	140	mA
V_{TRIKL}	Trickle Charge Threshold Voltage	R_{PROG}=1.2K, V_{BAT} Rising		2.8	2.9	3.0	V
V_{UV}	V_{CC} Undervoltage Lockout Threshold	From VCC Low to High	●	3.4	3.6	3.8	V
I_{TERM}	C/5 termination current limit	R_{PROG}=0.68K	●	150	200	250	mA
V_{PROG}	PROG Pin Voltage	R_{PROG}=1.2K，Current Mode	●	0.9	1.0	1.1	V
$V_{\overline{CHRG}}$	$\overline{CHRG}$ Pin output low voltage	$I_{\overline{CHRG}}$ =5mA			0.3	0.6	V
$V_{\overline{STDBY}}$	$\overline{STDBY}$ Pin output low	$I_{\overline{STDBY}}$ =5mA			0.3	0.6	V
ΔV_{RECHRG}	Recharge Battery Threshold Voltage	V_{FLOAT} -V_{RECHRG}		100	150	200	mV
T_{LIM}	Junction Temperature in Constant Temperature Mode				120		℃
Charging R_{ON}	Power FET “ON” Resistance (Between V_{CC} and BAT)				450		mΩ
t_{ss}	Soft-Start Time	I_{BAT} = 0 to I_{BAT} =700V/R_{PROG}			20		ms
t_{TERM}	Termination Comparator Filter Time	IBAT Falls Below ICHG/5		0.8	1.8	4	ms
VOUT	Boost voltage	Rload=1k		4.875	5	5.125	V
V_{BatLOW}	Battery Undervoltage Protection	Vbat Drops From 3.6V	●	2.5	2.7	2.9	V
$V_{BatHigh}$	Battery Undervoltage Protection Unlocked	Vbat Rises From 2.7V	●	2.8	3	3.2	V

F_{OSC}	Oscillation Frequency			300	400	500	KHZ
Dty	MaximumDuty cycle				75		%
η_{boost}	Boost efficiency	V_{BAT}=3.8V I_{OUT}=500mA			90		%
η_{boost}	Boost efficiency	V_{BAT}=3.8V I_{OUT}=1000mA			88		%
Boost R_{ON}	Boost NMOS Tube Internal Resistance	V_{LX}=0.4V			120		mΩ
I_{Lxleak}	Boost NMOS Leakage Current	V_{LX}=6V				1	uA
Ilmt_nmos	Boost Switch Current Limiting				4	4.5	A

Pin Function

1	VOUT	Output voltage detection pin
2	$\overline{CHRG}$	Open-Drain Charge Status Output
3	PROG	Charge Current Program, Charge Current Monitor and Shutdown Pin
4	$\overline{STDBY}$	Charge indicator status
5	VCC	The positive input terminal of the input voltage of the charger
6	BAT	Charge Current Output
7	GND	Power Ground
8	LX	The output of the internal power tube of the boost circuit

Block diagram



Normal Charge Cycle

A charge cycle begins when the voltage at the V_{CC} pin rises above the UVLO threshold level and a 1% program resistor is connected from the PROG pin to ground or when a battery is connected to the charger output. If the BAT pin is less than 2.9V, the charger enters trickle charge mode. In this mode, the TP5410 supplies approximately 1/5 the programmed charge current to bring the battery voltage up to a safe level for full current charging.

When the BAT pin voltage rises above 2.9V, the charger enters constant-current mode, where the programmed charge current is supplied to the battery. When the BAT pin approaches the final float voltage (4.2V), the TP5410 enters constant-voltage mode and the charge current begins to decrease. When the charge current drops to 1/5 of the programmed value, the charge cycle ends.

Programming Charge Current

The charge current is programmed using a single resistor from the PROG pin to ground. The battery charge current is 700 times the current out of the PROG pin. The program resistor and the charge current are calculated using the following equations:

$$R_{PROG} = \frac{700}{I_{BAT}}$$

In the customer's application, the relationship between RPROG and charging current can be determined by referring to the following table:

R_{PROG} （Ω）	I_{BAT}
10k	80mA
5k	160mA
1.2k	580mA
0.75k	900mA
0.68k	1000mA

Charge Termination

A charge cycle is terminated when the charge current falls to 1/5th the programmed value after the final float voltage is reached. This condition is detected by using an internal, filtered comparator to monitor the PROG pin. When the PROG pin voltage falls below 200mV for longer than t_{TERM} (typically 1.8ms), charging is terminated. The charge current is latched off and the TP5410 enters standby mode, where the input supply current drops to 40μA. (Note: C/5 termination is disabled in trickle charging and thermal limiting modes). When charging, transient loads on the BAT pin can cause the PROG pin to fall below 200mV for short periods of time before the DC charge current has dropped to 1/5th the programmed value. The 1.8ms filter time (t_{TERM}) on the termination comparator ensures that transient loads of this nature do not result in premature charge cycle termination. Once the average charge current drops below 1/5th the programmed value, the TP5410 terminates the charge cycle and ceases to provide any current through the BAT pin. In this state, all loads on the BAT pin must be supplied by the battery.

The TP5410 constantly monitors the BAT pin voltage in standby mode. If this voltage drops below the 4.1V recharge threshold (V_{RECHRG}), another charge cycle begins and current is once again supplied to the battery. To manually restart a charge cycle when in standby mode, the input voltage must be removed and reapplied, or the charger must be shut down and restarted using the PROG pin.

Undervoltage Lockout (UVLO)

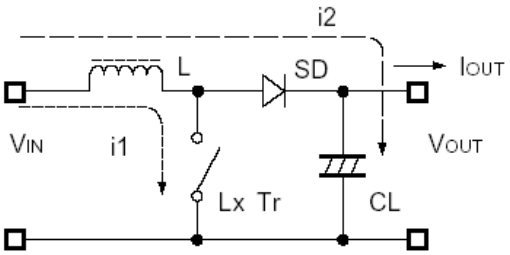
An internal undervoltage lockout circuit monitors the input voltage and keeps the charger in shutdown mode until V_{CC} rises above the undervoltage lockout threshold. The UVLO circuit has a built-in hysteresis of 200mV. Furthermore, to protect against reverse current in the power MOSFET, the UVLO circuit keeps the charger in shutdown mode if V_{CC} falls to within 30mV of the battery voltage. If the UVLO comparator is tripped, the charger will not come out of shutdown mode until V_{CC} rises 50mV above the battery voltage.

Automatic Recharge

Once the charge cycle is terminated, the TP5410 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 4.1V (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. CHRG output enters a strong pulldown state during recharge cycles.

Boost Discharge Circuit

Boost circuit stores energy by the inductor and then discharges with the input power together supply to obtain the output voltage higher than the input voltage. As shown below:



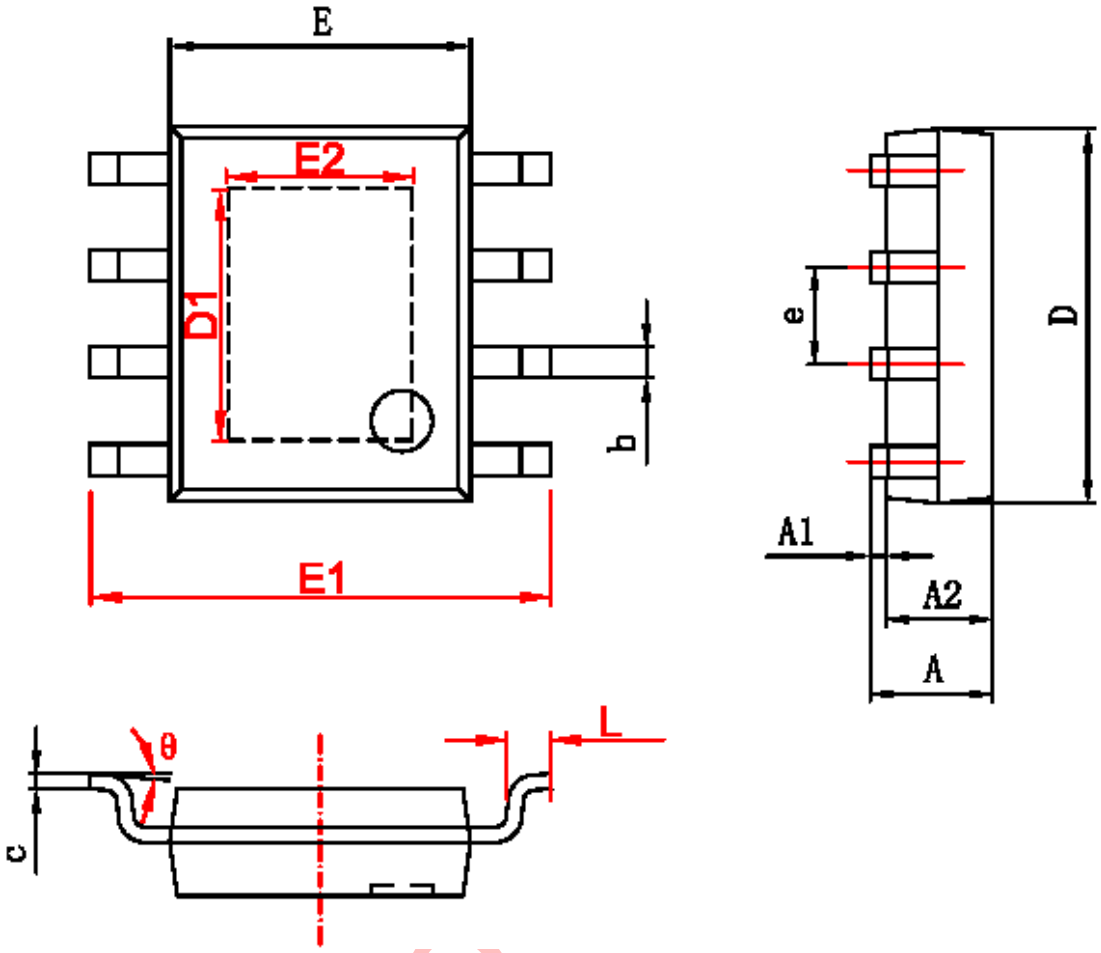
When the VCC pin is not connected to the power supply and the Li-Ion battery voltage is in the range of 3V-4.2V, the boost circuit starts automatically and the 5V constant voltage source is continuously output. When the BAT voltage is 3V-4.2V and the input power supply Vcc is less than 3.8V, or Vcc<Vbat+50mV and the PROG pin is left floating, the boost operation will also work.

Output voltage trimming function

The boost output voltage can be adjusted by a string of external resistors between the diode and the VOUT pin. After adjustment, the driving capacity will be reduced accordingly.

Output voltage	R
5.25V	293K
5.5V	479K
6V	710K
6.5V	1.12M

Package description



character	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.150	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
D1	3.202	3.402	0.126	0.134
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.313	2.513	0.091	0.099
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

NOTICE

1、To prove reliability, we advice to locate capacitors of Vcc, Bat and Vout near the pins as close as possible. Besides, a 0.1uF ceramic capacitor should be paralleled next to the pins as well.

2、It is recommended to use two 22uF capacitors in parallel at the BAT end, and the capacitance value at the VOUT end should not be less than 47μF (too small capacitance value will cause the chip to work unstable, and it is strongly required to use tantalum capacitors or electrolytic capacitors at the VOUT end), and connect a 5.5V~6.8V TVS diode to make it have better frequency characteristics. In addition, because the LX switch drive transistor produces a peak voltage when it is turned off, the capacitance value of the capacitor is at least three times the design output voltage.

3、Inductance value recommended 3.3-22uH, typically 10uH.

4、External diode recommended Schottky diode, SS32 is recommended.

5、The line between Vout pin and load should be as short as possible because of large output current.

6、Gnd pin must be well-linked to ground or the chip's operation may be instable.