28V High Input Voltage， OVP Threshold 6.5V， Li-ion Battery Charger

Description

PW4057 is a complete constant-current & constant voltage linear charger for single cell lithium-ion and Lithium-Polymer batteries with direct interface with standard USB port. PW4057 is specifically designed to work within USB power specification and direct interface.

PW4057 will block all incoming voltage if 6.5V or above is detected. When Vin falls within 6.5V, the internal Power MOS is turned on and starts the normal charging cycle.

The charge voltage is fixed at 4.22V, and the charge current can be programmed externally with a single resistor. The PW4057 automatically terminates the charge cycle when the charge current drops to 1/10th the programmed value after the final float voltage is reached.

Other features include charge current monitor, undervoltage lockout, automatic recharge and a status pin to indicate charge termination and the presence of an input voltage. PW4057 is intentionally designed to have slightly negative Tempco. This provides extra protection to Lithium battery during charging.

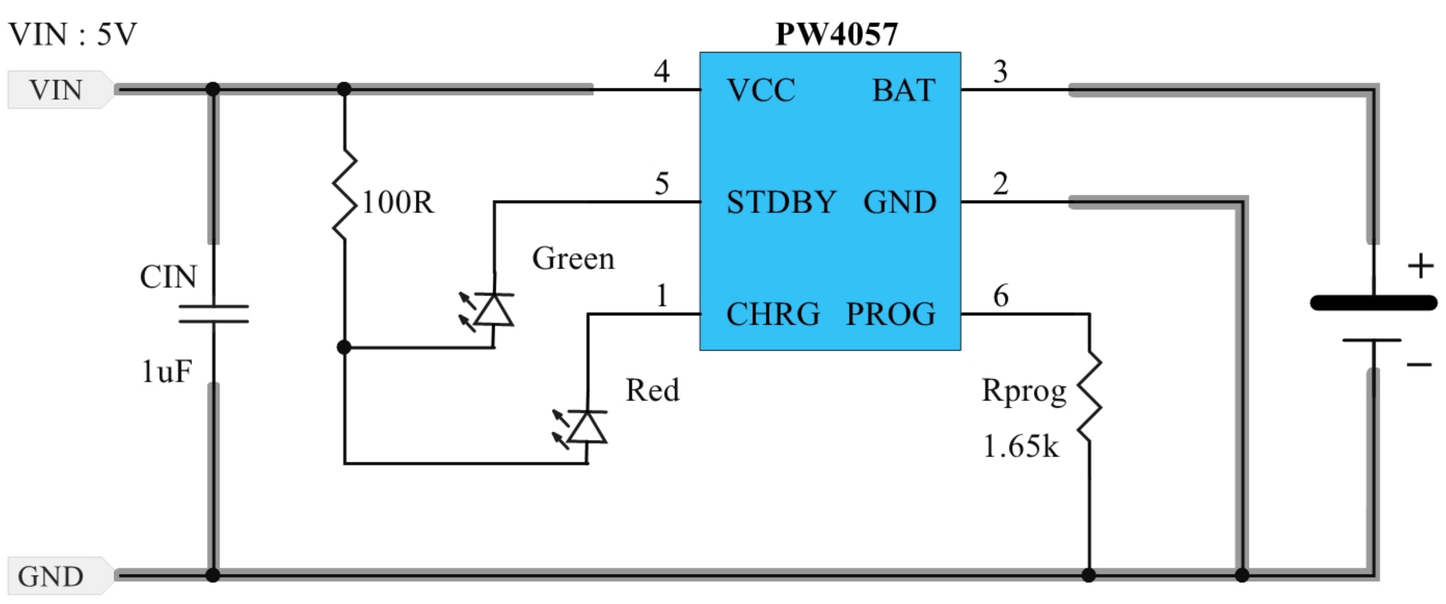
Features

- Programmable Charge Current Up to 600mA.
- No MOSFET, Sense Resistor or Blocking Diode Required.
- Rate without Risk of Overheating.
- Charges Single Cell Li-Ion Batteries Directly from USB Port.
- Preset 4.22V Charge Voltage with ±1% Accuracy.
- 20uA Supply Current in Shutdown.
- 2.9V Trickle Charge Threshold
- Soft-Start Limits Inrush Current.
- Available in 6-Lead SOT-23

Application

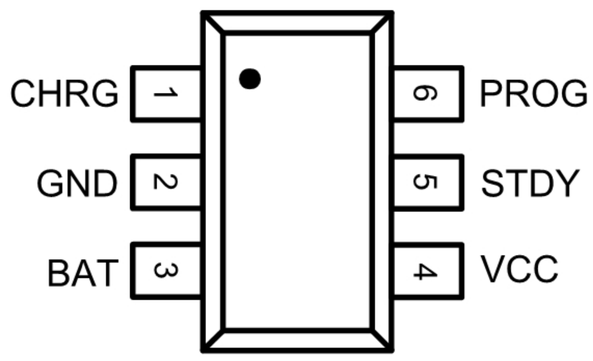
- Cellular Telephones, PDA's, MP3 Players.
- Charging Docks and Cradles
- Bluetooth Applications

Application Diagram



IBAT (A)=1091.8 / Rprog。 Rprog=1.65K， IBAT=0.661A

Pin Configuration



Number	Pin	Pin Function Description
1	CHRG	Open-Drain Charge Status Output. When the battery is charging, the CHRG pin is pulled low by an internal N-channel MOSFET. When the charge cycle is completed, a weak pull-down of approximately 20uA isconnected to the CHRG pin, indicating an “AC present” condition.
2	GND	Ground
3	BAT	Charge Current Output. Provides charge current to the battery and regulates the final float voltage to 4.22V.
4	VCC	Positive Input Supply Voltage. Provides power to the charger. VCC can range from 3.5V to 6.5V and should be bypassed with at least a 1uF capacitor.
5	STDBY	Open-Drain Charge Termination Status Output. When the battery is charging, the STDBY pin is pulled high by an external compenent such as an LED. After the charging is completed, this pin is pulled low by internal N-channel MOSFET and it can be used as a charging termination indicator.
6	PROG	Charge Current Program, Charge Current Monitor and Shutdown Pin.

产品	输入电压范围	充电电流	锂电池（串联）	LED	封装	备注
PW4052	4.7V~5.5V	~2.5A	1节	双灯	SOP8-EP	可设置至2.5A充电电流
PW4202	3.0V~6V	~3A	2节	双灯	SOP8	5V充两串锂电池
PW4053	3.5V~6V	~1.2A	3节	单灯	SOP8-EP	5V充三串锂电池
PW4053M	2.7V~6.5V	~3A	3节	双灯	SOP8	5V充三串锂电池
PW4405	2.7V~6.5V	~3A	4节	双灯	SOP8	5V充四串锂电池
PW4204	7.5V~28V	~5A	4节	双灯	TSSOP16	20V充四串锂电池
PW4065	4V~12V	~600mA	1节	单灯	SOT23-5L	输入/输出短路保护，3MA充电
PW4203	4.5V~24V	~2A	1~3节	单灯	SOP8-EP	可设置几节锂电池S
PW4054	4.5V~6.5V	~500mA	1节	单灯	SOT23-5L	常规5PIN充电产品
PW4054T	4.5V~6V	~300mA	1节	单灯	SOT23-5L	1mA截至电流，极低功耗
PW4556	4.5V~5.5V	~250mA	1节	单灯	TDFN1X1-L	体积小充电产品
PW4056	4.5V~6.5V	~1A	1节	双灯	SOP8-EP	常规8 PIN充电产品
PW4555	4.5V~24V	~700mA	1节	双灯	DFN-2×2-8L	带OVP保护充电产品
PW4057	4.5V~28V	~800mA	1节	双灯	SOT23-6L	带OVP保护版4057
PW4056H	4.5V~28V	~1A	1节	双灯	SOP8-EP	带OVP保护版4056

Absolute Maximum Rating

Symbol	Parameter	Value	Units
VCC	Input Supply Voltage	28	V
VPROG	PROG Voltage	VCC+0.3	V
VBAT	BAT Voltage	7	V
VCHRG	CHRG Voltage	7	V
	BAT Short-Circuit Duration	Continuous	
θJA	Thermal Resistance, Junction-to-Ambient	250	°C/W
IBAT	BAT Pin Current	800	mA
IPROG	PROG Pin Current	800	uA
Tj	Maximum Junction Temperature	125	°C
Ts	Storage Temperature	-65 to +125	°C
	Lead Temperature (Soldering, 10 sec)	260	°C

Note : Exceeding the absolute maximum rating may damage the device.

Operating Rating

Parameter	Symbol	Value	Units
Supply Input Voltage	VIN	-0.3 to +28	V
Junction Temperature	TJ	-40 to +85	°C

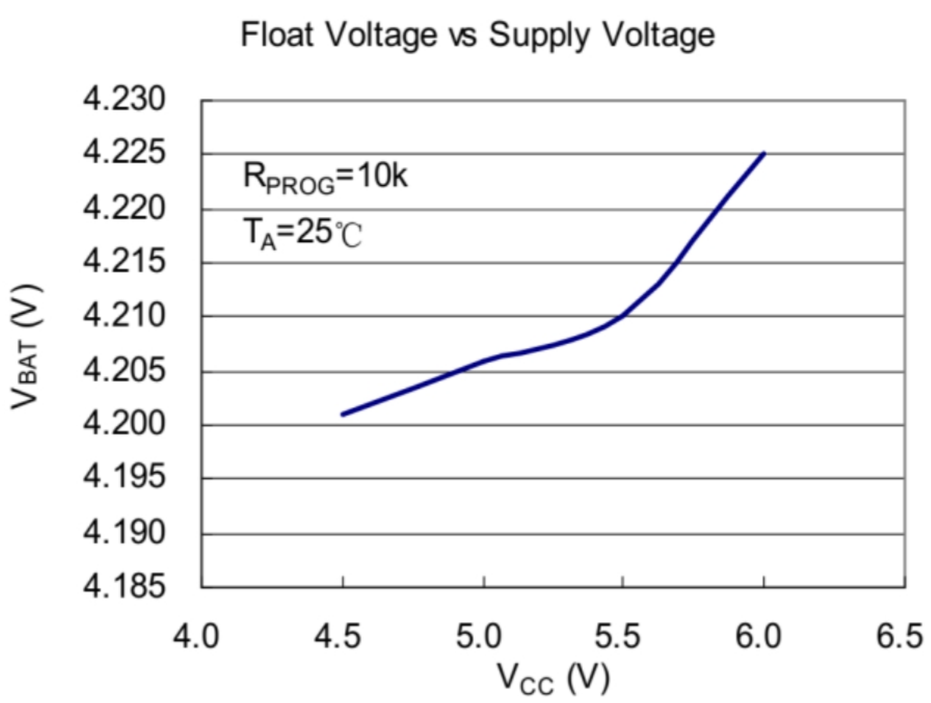
Note : The device is not guaranteed to function outside its operating rating.

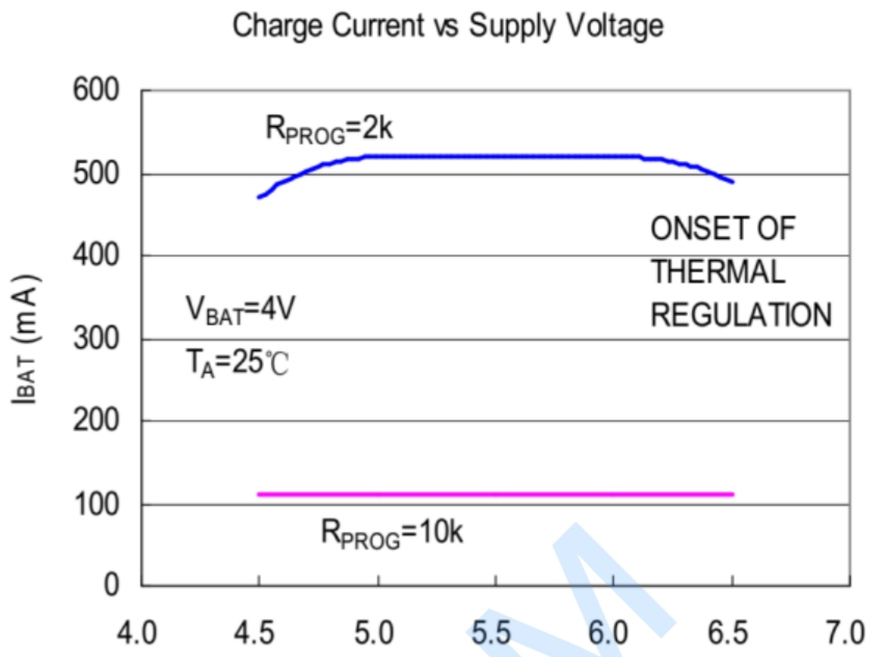
Electrical Characteristics (VIN = 5V; TJ = 25°C; unless otherwise specified)

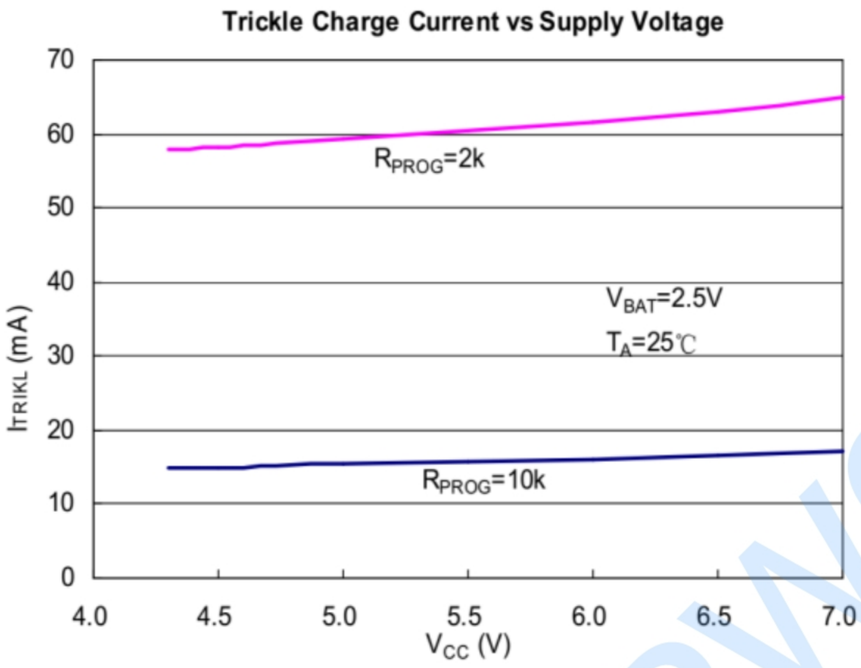
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
VCC	Input Supply Voltage		3.5		28	V
ICC	Input Supply Current	Charge Mode , RPROG = 10k		110	500	μA
		Standby Mode (Charge Terminated)		70		μA
		Shutdown Mode (RPROG Not Connected, VCC < VBAT, or VCC < VUV)		20	40	μA
VFLOAT	Regulated Output (Float)	IBAT = 30mA, ICHRG = 5mA	4.15	4.22	4.3	V
IBAT	BAT Pin Current	RPROG = 10k, Current Mode	90	106	130	mA
		RPROG = 2k, Current Mode		530		mA
		Standby Mode, VBAT = 4.2V	0	±1	±5	μA
		Shutdown Mode (RPROG Not Connected)		±0.5	±5	μA
		Sleep Mode, VCC = 0V		±1	±5	μA
ITRIKL	Trickle Charge Current	VBAT < VTRIKL, RPROG = 10k		10		mA
VTRIKL	Trickle Charge Threshold	RPROG = 10k, VBAT Rising	2.8	2.9	3.0	V
VUV	VCC Undervoltage Lockout Threshold	From VCC Low to High		3.4		V
VUVHYS	VCC Undervoltage Lockout Hysteresis			100		mV
VMSD	Manual Shutdown Threshold Voltage	PROG Pin Rising		1.25		V
		PROG Pin Falling		1.2		V
VASD	VCC – VBAT Lockout Threshold Voltage	VCC from Low to High		100		mV
		VCC from High to Low		30		mV
ITERM	C/10 Termination Current Threshold	RPROG = 10k		0.1		mA/mA
		RPROG = 2k		0.1		
VPROG	PROG Pin Voltage	RPROG = 10k, Current Mode	0.9	1.03	1.1	V
VCHRG	CHRG Pin Output Low Voltage	ICHRG = 5mA		0.6		V
ΔVRECHRG	Recharge Battery Threshold	VFLOAT - VRECHRG		100		mV
TLIM	Thermal Protection Temperature			120		°C
tSS	Soft-Start Time	IBAT = 0 to 1000V/RPROG		100		μs
tRECHARGE	Recharge Comparator Filter Time	VBAT High to Low		1		ms
tTERM	Termination Comparator Filter Time	IBAT Falling Below ICHG/10		1000		μs
IPROG	PROG Pin Pull-Up Current			1		μA

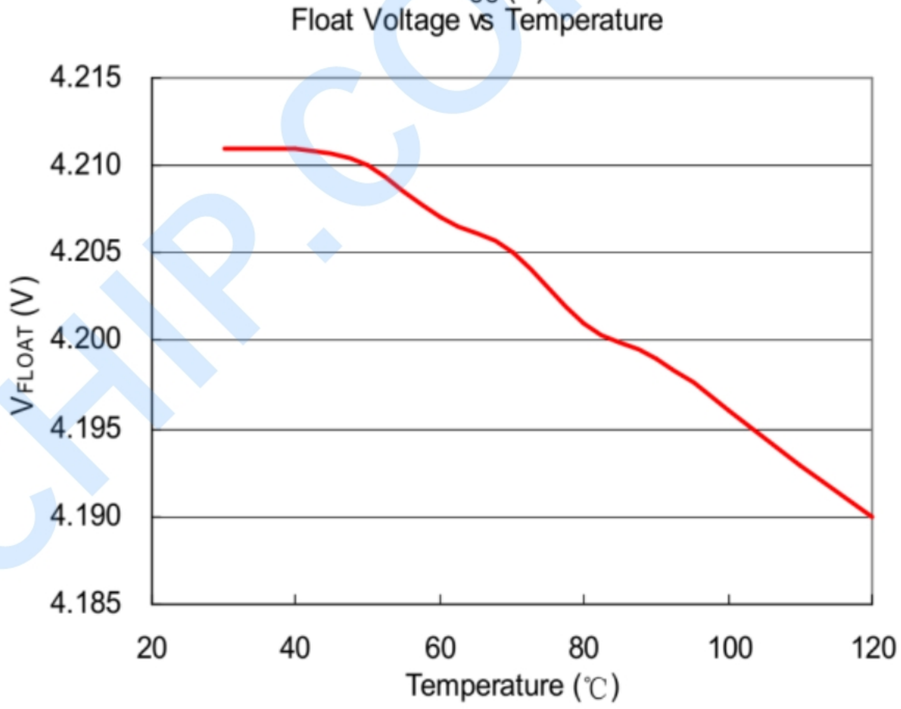
Note : Supply current includes PROG pin current (approximately 100μA) but does not include any current delivered to the battery through the BAT pin (approximately 100mA).

Typical Characteristics









Operation

The PW4057 is a single cell lithium-ion battery charger using a constant-current/constant-voltage algorithm. It can deliver up to 800mA of charge current (using a good thermal PCB layout) with a final float voltage accuracy of ±1%. The PW4057 includes an internal P-channel power MOSFET and thermal regulation circuitry. No blocking diode or external current sense resistor is required; thus, the basic charger circuit requires only two external components. Furthermore, the PW4057 is capable of operating from a USB power source.

Normal Charge Cycle

A charge cycle begins when the voltage at the VCC 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 2.8V, the charger enters trickle charge mode. In this mode, the PW4057 supplies approximately 1/10 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 2.8V, 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 (4.22V), the PW4057 enters constant-voltage mode and the charge current begins to decrease. When the charge current drops to 1/10 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 current are calculated using the following equations:

$$R_{PROG} = \frac{1060V}{I_{CHG}}, I_{CHG} = \frac{1060V}{R_{PROG}}$$

The charge current out of the BAT pin can be determined at any time by monitoring the PROG pin voltage using the following equation:

$$I_{BAT} = \frac{V_{PROG}}{R_{PROG}} \bullet 1060$$

This actual current will vary from IC to IC. The typical variation is within ±20%.

Charge Termination

A charge cycle is terminated when the charge current falls to 1/10th 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 100mV for longer than tTERM (typically 1ms), charging is terminated. The charge current is latched off and the PW4057 enters standby mode, where the input supply current drops to 200mA. (Note: C/10 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 100mV for short periods of time before the DC charge current has dropped to 1/10th the programmed value. The 1ms filter time (tTERM) 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 1/10th the programmed value, the PW4057 terminates the charge cycle and ceases to provide any current through the BAT pin. In this state, all loads on the in standby mode. If this voltage drops below the4.05V recharge threshold (VRECHRG), 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.

Charge Status Indicator

CHRG Pin and STDBY pin indicates different charge states. When PW4057 is in a charge cycle, CHRG Pin is pull-down (~10mA), and STDBY pin is high impedance. Once the charge cycle has terminated, the CHRG pin is high impedance and STDBY pin is pull-down.

Thermal Limiting

An internal thermal feedback loop reduces the programmed charge current if the die temperature attempts to rise above a preset value of approximately 120℃. This feature protects the PW4057 from excessive temperature and allows the user to push the limits of the power handling capability of a given circuit board without risk of damaging the PW4057. The charge current can be set according to typical (not worst-case) ambient temperature with the assurance that the charger will automatically reduce the current in worst-case conditions.

Undervoltage Lockout (UVLO)

An internal undervoltage lockout circuit monitors the input voltage and keeps the charger in shutdown mode until VCC 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 VCC falls to within 30mV of the battery voltage. If the UVLO comparator is tripped, the charger will not come out of shutdown mode until VCC rises 100mV above the battery voltage.

Application Hints

Stability Considerations

The constant-voltage mode feedback loop is stable without an output capacitor provided a battery is connected to the charger output. With no battery present, an output capacitor is recommended to reduce ripple voltage. When using high value, low ESR ceramic capacitors, it is recommended to add a 1Ω resistor in series with the capacitor. No series resistor is needed if tantalum capacitors are used.

In constant-current mode, the PROG pin is in the feedback loop, not the battery. The constant-current mode stability is affected by the impedance at the PROG pin. With no additional capacitance on the PROG pin, the charger is stable with program resistor values as high as 20k. However, additional capacitance on this node reduces the maximum allowed program resistor. The pole frequency at the PROG pin should be kept above 100kHz.

VCC Bypass Capacitor

Many types of capacitors can be used for input bypassing, however, caution must be exercised when using multilayer ceramic capacitors. Because of the self-resonant and high Q characteristics of some types of ceramic capacitors, high voltage ransients can be generated under some start-up conditions, such as connecting the charger input to live power source. Adding a 1.5Ω resistor in series ith a ceramic capacitor will minimize start-up oltage transients.

Power Dissipation

The conditions that cause the PW4057 to reduce aharge current through thermal feedback can be approximated by considering the power dissipated in the IC. Nearly all of this power dissipation is generated by the internal MOSFET—this is calculated to be approximately:

$$P_D = (V_{CC} - V_{BAT}) \bullet I_{BAT}$$

The approximate ambient temperature at which the thermal feedback begins to protect the IC is:

$$T_A = 120°C - P_D\theta_{JA}$$

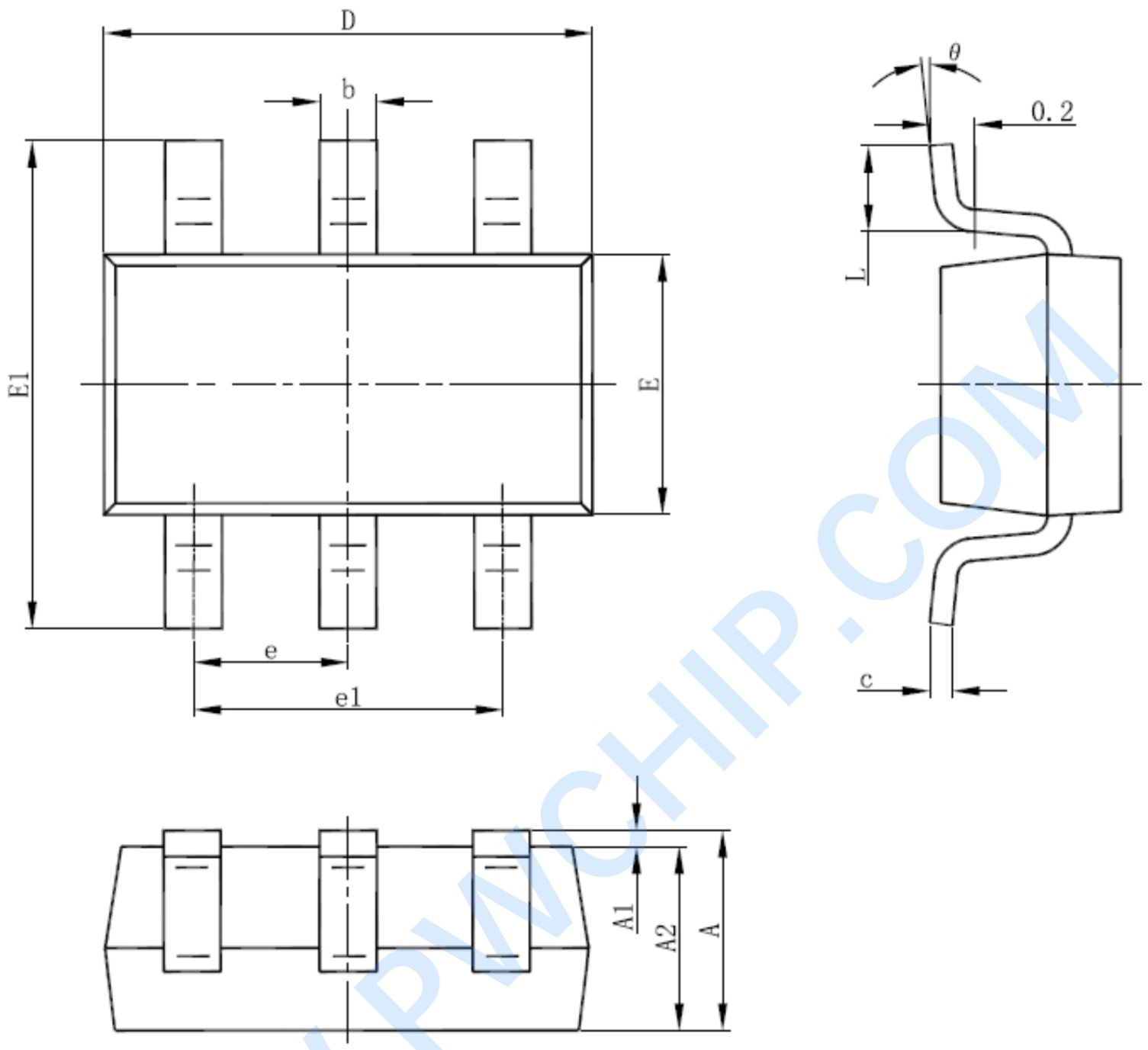
$$T_A = 120°C - (V_{CC} - V_{BAT}) \bullet I_{BAT} \bullet \theta_{JA}$$

Thermal Considerations

Because of the small size of the thin SOT23 package, it is very important to use a good thermal PC board layout to maximize the available charge current. The thermal path for the heat generated by the IC is from the die to the copper lead frame, through the package leads, (especially the ground lead) to the PC board copper. The PC board copper is the heat sink. The footprint copper pads should be as wide as possible and expand out to larger copper areas to spread and dissipate the heat to the surrounding ambient. Other heat sources on the board, not related to the charger, must also be considered when designing a PC board layout because they will affect overall temperature rise and the maximum charge current.

PACKAGE DESCRIPTION

SOT23-6L



Symbol	Dimensions In Millimeters	
	Min	Max
A	0.900	1.450
A1	0.000	0.150
A2	0.900	1.300
b	0.300	0.500
c	0.100	0.200
D	2.800	3.000
E	1.500	1.700
E1	2.650	2.950
e	0.950(BSC)	
e1	1.800	2.000
L	0.300	0.600
θ	0°	8°

IMPORTANT NOTICE

Wuxi PWChip Semi Technology CO., LTD (PW) reserves the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any products or services. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

PW assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using PW components.

PW products are not authorized for use in safety-critical applications (such as life support devices or systems) where a failure of the PW product would reasonably be expected to affect the safety or effectiveness of that devices or systems.

The information included herein is believed to be accurate and reliable. However, PW assumes no responsibility for its use; nor for any infringement of patents or other rights of third parties which may result from its use.