

■ General Description

The XT2052 is a constant- current / constant- voltage charger circuit for single cell lithium-ion batteries. The device includes an internal power transistor, does not need external current sense resistor and blocking diode in applications. XT2052 requires minimal external components, and meet the USB bus specification, is very suitable for portable applications in the field.

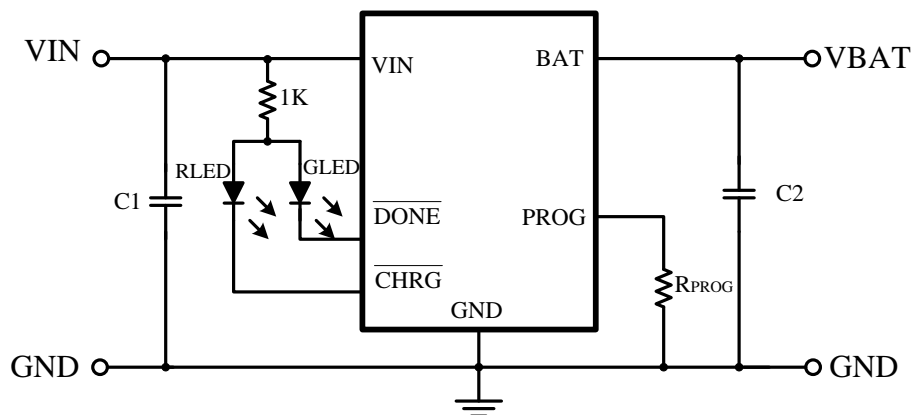
Thermal modulation circuit can control the internal chip temperature in a safe range when the device power dissipation be relatively large or the ambient temperature be higher. Within a fixed constant charge voltage 4.2V, can also be adjusted by an external resistor.

When the input voltage (AC adapter or USB power supply) power is lost, XT2052 automatically enters a low power sleep mode, then the battery current consumption is less than 0.1μA. Built-in protection circuits against irrigation, when the battery voltage is higher than the input voltage, automatically turn off built-in power MOSFET. Other features include low input voltage latch, automatic recharge, the battery temperature monitoring, and charge status / charge status indication functions. XT2052 uses thermally enhanced 8-pin small outline package ESOP8.

■ Package

- ESOP8

■ Typical Application Circuit



注: C1=4.7uF, C2=10uF, IBAT = (VPROG/RPROG)*1000

■ Features

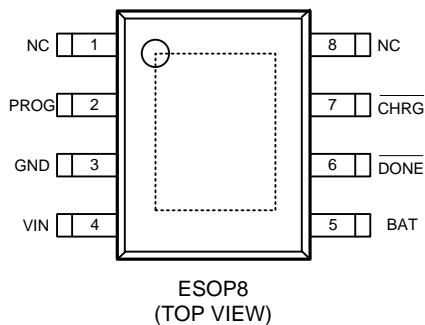
- Programmable charge current up to 1A
- No MOSFET, sense resistor or blocking diode required
- Complete linear charger in small package for single cell lithium-ion batteries
- Constant-current/constant-voltage operation with thermal regulation to maximize charge rate without risk of overheating
- Charges single cell li-ion batteries directly from USB port
- Preset 4.2V charge voltage with 1% accuracy
- Monitor output charge current
- Automatic recharge
- Charge status output pin
- 1/10 charge current termination
- 40μA supply current in shutdown
- 2.9V trickle charge threshold
- Soft-Start limits inrush current
- Output with protection against anti-irrigation
- Available in ESOP8 or customer order form
- When you unplug VIN , the IC does not consume battery power

■ Ordering Information

XT2052①②③④⑤

| Designator | Description | Symbol | Description |
|------------|--|--------|---------------------|
| ① | Type | X | No trickle charge |
| | | Y | Have trickle charge |
| ② | The first part of regulator Output Voltage | 0 | 4.0 |
| | | 1 | 4.1 |
| | | 2 | 4.2 |
| ③ | The second part of regulator Output Voltage | A | ②00 |
| | | B | ②25 |
| | | C | ②50 |
| | | D | ②75 |
| ④ | Packaging Types | S | ESOP8 |
| ⑤ | Device Orientation | R | positive |
| | | L | negative |

■ Pin Configuration



■ Pin Assignment

| 引脚号 | 引脚名称 |
|--------------|--------------------------|
| ESOP8 | |
| 1 | NC |
| 2 | PROG |
| 3 | GND |
| 4 | VIN |
| 5 | BAT |
| 6 | $\overline{\text{DONE}}$ |
| 7 | $\overline{\text{CHRG}}$ |
| 8 | NC |

■ 引脚功能

- **PROG (Pin 2):** Charge current programming, charge current monitoring and close pin. Charge current is controlled by a resistor of precision of 1% to the ground. In the constant charge current state, this port provides 1V voltage. In all conditions, this port charge current can be calculated using the following formula:

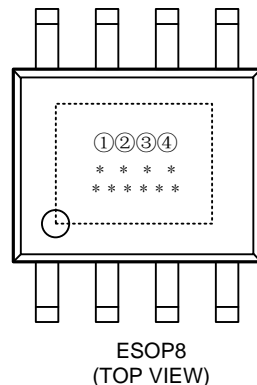
$$I_{BAT} = (V_{PROG}/R_{PROG}) \times 1000$$

PROG port can also be used to turn off the charger. Resistance to side with the separation of programming can pull the 3uA current source to increase PROG port voltage. When the suspension reached the limit voltage 1.21V, the device enters stop state, after charging the input current drop to 25A. This port pinch-off voltage is about 2.4V. If supply this port voltage more than pinch-off voltage, the current will be 1.5 mA. Through combination PROG pin to the ground, the charger will back to normal.

- **GND (Pin 3):** Ground terminal, The EXPOSED pin is also connected with pin 3.
- **VIN (Pin 4):** Supply positive input voltage. Power supply for the charger. VIN can be 4.25V to 6.5V and must have at least 1F bypass capacitor. If the BAT pin voltage of VIN down to within 30 mV, XT2052 into the suspension state, and make BAT Current less than 2A.
- **BAT (Pin 5):** Make the battery's positive terminal connected to this pin. When the powers supply voltage lower than the threshold latch voltage or sleep mode voltage, BAT pin current is less than 2μA. BAT pin provide the battery charge current and constant voltage charging voltage.
- **DONE (Pin 6):** When charging end, DONE pin is pulled low by internal switch represents that charge has ended; otherwise DONE pin is high impedance state.
- **CHRG (Pin 7):** When the charger to the battery charging, CHRG pin is pulled low by the internal switch, represents charging being; otherwise CHRG pin is in high impedance state.

■ Marking Rule

- ESOP8



①②③表示晶圆版本号，④表示生产信息

第二行、第三行为公司内部的质量跟踪信息。

The second and line the third line stand for the company's quality tracking information.

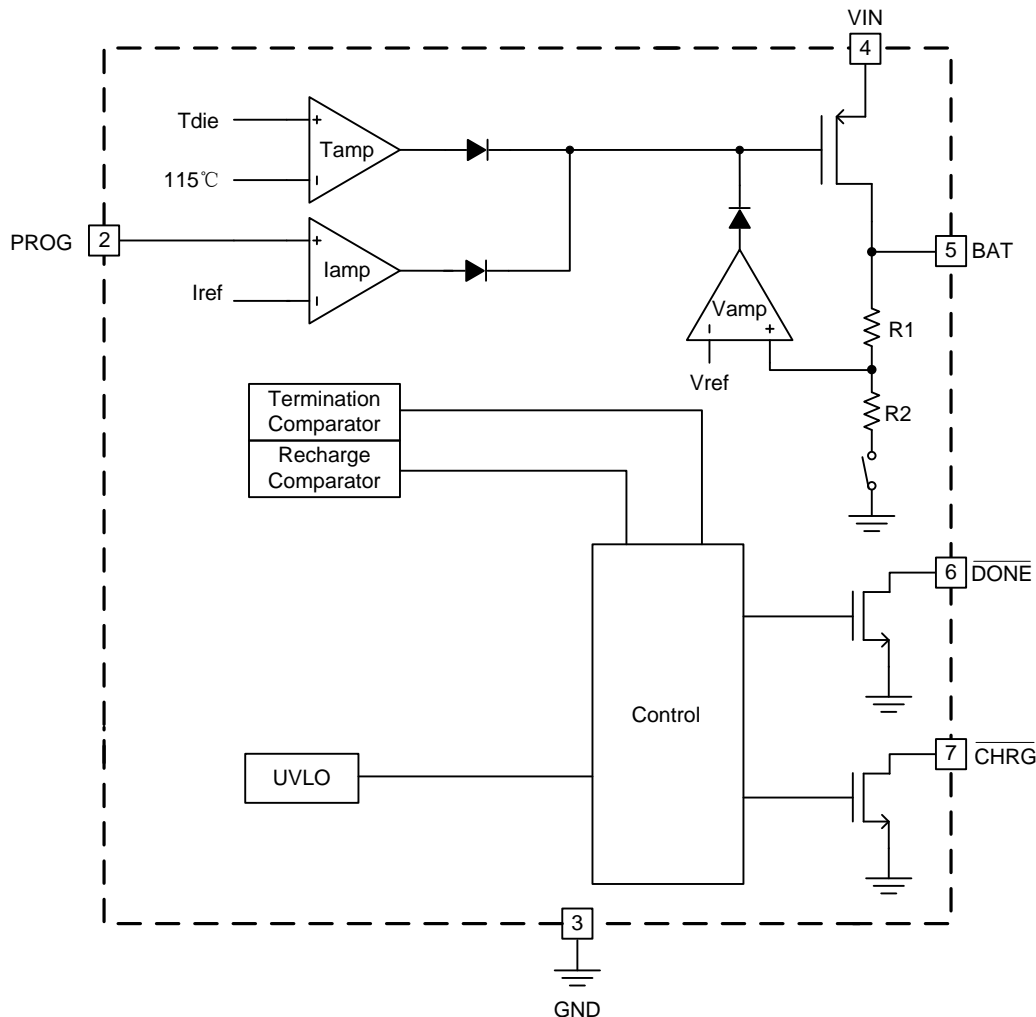
①②③Represents the version number, ④ Represents the production information.

Absolute Maximum Ratings

| Parameter | Symbol | Maximum Rating | Unit |
|-------------------------------|--------|------------------------------|-------------|
| Input Supply Voltage | VIN | $V_{SS}-0.3 \sim V_{SS}+7$ | V |
| PROG pin Voltage | Vprog | $V_{SS}-0.3 \sim V_{IN}+0.3$ | |
| BAT pin Voltage | Vbat | $V_{SS}-0.3 \sim 6$ | |
| \overline{DONE} pin Voltage | Vdone | $V_{SS}-0.3 \sim V_{SS}+7$ | |
| \overline{CHRG} pin Voltage | Vchrg | $V_{SS}-0.3 \sim V_{SS}+7$ | |
| BAT pin Current | Ibat | 1500 | mA |
| PROG pin Current | Iprog | 1500 | μA |
| Operating Ambient Temperature | Topa | -40~+85 | $^{\circ}C$ |
| Storage Temperature | Tstr | -65~+125 | |

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

Block Diagram



■ Electrical Characteristics

(Ta=25°C, Unless specifically designated)

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|-------------------------------------|---------------------|---|------|------|------|------|
| Input supply voltage | VIN | - | 4.25 | - | 6.5 | V |
| Input supply current | Iin | Charge mode, R _{PROG} =10K | - | 200 | 2000 | μA |
| | | Standby mode | - | 200 | 500 | μA |
| | | Shutdown mode(R _{PROG} not connected, Vin< Vbat or Vin< Vuv) | - | 25 | 70 | μA |
| Regulated Output Voltage | Vfloat | 0°C≤TA≤85°C, I _{BAT} =40mA | 4.16 | 4.2 | 4.25 | V |
| BAT pin Current | I _{bat} | R _{PROG} =10k, Current mode | 90 | 100 | 110 | mA |
| | | R _{PROG} =1k, Current mode | 900 | 1000 | 1100 | mA |
| | | Standby mode, Vbat=4.2V | 0 | -2.5 | -6 | μA |
| | | Shutdown mode | - | - | ±0.1 | μA |
| | | Sleep mode, Vin=0V | - | - | ±0.1 | μA |
| Trickle charge current | I _{trikl} | Vbat<V _{trikl} , R _{PROG} =2k | 90 | 100 | 110 | mA |
| Trickle charge Threshold Voltage | V _{trikl} | R _{PROG} =10K, Vbat Rising | 2.8 | 2.9 | 3.0 | V |
| Trickle voltage hysteresis voltage | V _{trhys} | R _{PROG} =10k | 60 | 80 | 110 | mV |
| VIN Undervoltage lockout Threshold | Vuv | From Vin low to high | 3.7 | 3.8 | 3.93 | V |
| VIN undervoltage lockout hysteresis | Vuvhys | - | 150 | 200 | 300 | mV |
| Manual shutdown threshold voltage | V _{msd} | P _{ROG} pin rising | 1.15 | 1.21 | 1.30 | V |
| | | P _{ROG} pin falling | 0.9 | 1.0 | 1.1 | V |
| VIN-Vbat Lockout Threshold voltage | V _{asd} | Vin from low to high | 70 | 100 | 140 | mV |
| | | Vin from high to low | 5 | 30 | 50 | mV |
| C/10 Termination Current Threshold | I _{term} | R _{PROG} =10k | 8 | 10 | 12 | mA |
| | | R _{PROG} =2k | 40 | 50 | 65 | mA |
| PROG pin Voltage | V _{prog} | R _{PROG} =10k, Current mode | 0.93 | 1.0 | 1.07 | V |
| CHRG pin Output low voltage | V _{done} | I _{done} =5mA | - | 0.35 | 0.6 | V |
| CHRG pin Output low voltage | V _{chrg} | I _{chrg} =5mA | - | 0.35 | 0.6 | V |
| Recharge Battery threshold Voltage | Δ V _{recg} | VFLOAT - VRECHRG | - | 150 | 200 | mV |

■ Application Information

● Set the charge current

In constant-current mode, formula for calculating charge current: $I_{\text{PROG}} = 1000V / R_{\text{PROG}}$.

H represents the charges current, units are ampere, R_{PROG} represents PROG pin to ground resistance in ohms. For example, if you need 500 mA charges current, according to the following formula: $R_{\text{PROG}} = 1000V / 0.5A = 2K\Omega$

In order to ensure good stability and temperature characteristics, R_{PROG} recommend the use of 1% precision metal film resistors. By measuring the PROG pin voltage can be detected charge current. Charge current can be calculated using the following formula: $I_{\text{CH}} = (V_{\text{PROG}} / R_{\text{PROG}}) \times 1000$

● Application of USB and AC adapter while charging at the same time

XT2052 can not only use USB interface to charge the battery, users can also use a wall adapter to charge the battery. Figure 1 shows a same time using the USB interface and the AC adapter to charge the battery through the XT2052 .when the two co-exist, the AC adapter has priority. M1 is the P-channel MOSFET, M1 is used to prevent current from a wall adapter into the USB interface, Scotty diode D1 prevents the consumption of energy through the 1K resistor.

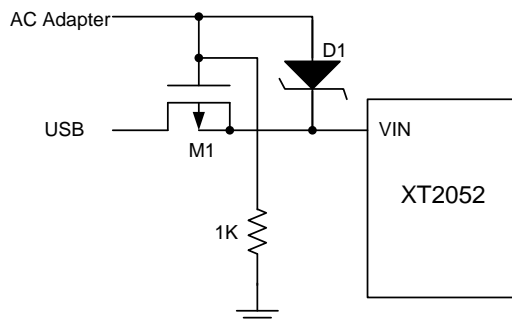


Figure1. While using the AC adapter and USB interfaces

● Battery temperature monitoring

In order to prevent the battery temperature is too high or too low, the damage caused by the battery, the XT2052 internal integrated battery temperature monitoring circuit.

● Enable design

By controlling whether the PROG pin resistor connected, users can reach close XT2052 function. Figure 2:

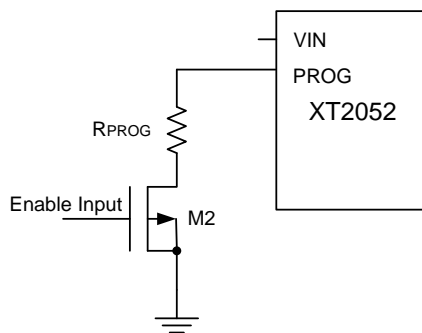


Figure 2

[ac adapter](#)

● Open-drain output status indication

XT2052 has two open-drain status indication sides, CHRG and DONE, the two status indicator LEDs client can drive or microcontroller port. CHRG used to indicate charging status, charging time, CHRG is low; DONE to indicate the charging end of the state, when the charging end, DONE is low. When the battery temperature is outside the normal temperature range more than 0.15 seconds, CHRG and the DONE pin is high impedance output state.

When the battery charger not received, the charger will quickly charge the output capacitor to the constant voltage value, as the battery voltage detection the BAT pin input leakage current, the BAT pin voltage will slowly down to recharge threshold, so the BAT pin voltage is 150mv to form a ripple waveform, while CHRG output pulse signal that there is no battery installed. When the battery BAT pin external connectors for the 4.7uF capacitor, the pulse period of about 2Hz.

The following table lists CHRG and DONE pin status in each case:

| State | Charge | Full | Without Battery | Error |
|-------|---------------|---------------|-----------------|------------|
| CHRG | Always bright | Always off | Flashing | Always off |
| DONE | Always off | Always bright | Always bright | Always off |

Note: 1. CHRG flicker frequency with external capacitor when not connect battery, generally recommended 4.7uF. The greater the capacitance, the smaller frequency flicker.

2. The error situation: Beyond the operating temperature range (temperature too high or too low), PROG side vacant, $V_{in} < V_{bat}$, $V_{in} < 3.8V$ and so on.

● The large current output design

Since the XT2052 using the internal constant power technology, therefore , when the input V_{IN} and BAT pressure is too large , will lead to smaller the BAT voltage range of the maximum current , so that the charging time becomes longer , in order to make the maximum current charging interval larger by an external resistor or Scotty methods to achieve.

The assumption the XT2052 of ESOP8 inside the package the maximum allowable power 1.2W, maximum charge current is set to 1.2A. If uses a resistive, We assume that the use of the resistance of 0.5Ω (1W), High current charging, the voltage drop across the resistor is $0.5 \times 1.2 = 0.6V$. The XT2052 real operating voltage is 4.4V. Thus, in this state, $(V_{IN} - V_{BAT}) \times 1.2 < 1.2W$, therefore $V_{BAT} > 3.6V$, The battery voltage is above 3.6V 1.2A charging support. Below 3.6V, the XT2052 will automatically reduce the charge current to maintain the chip internal power balance.

If Schottky similar calculation can be made, according to the Schottky voltage drop at different current .

In addition, in the high-current applications need to pay attention XT2052 PCB layout design must consider increasing EXPOSED PAD area, and will be connected to the EXPOSED PAD to GND in order to improve the thermal performance, and ensure the stable operation of the chip.

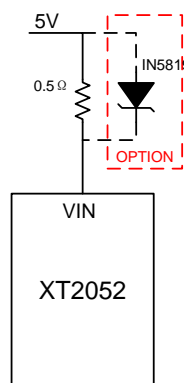
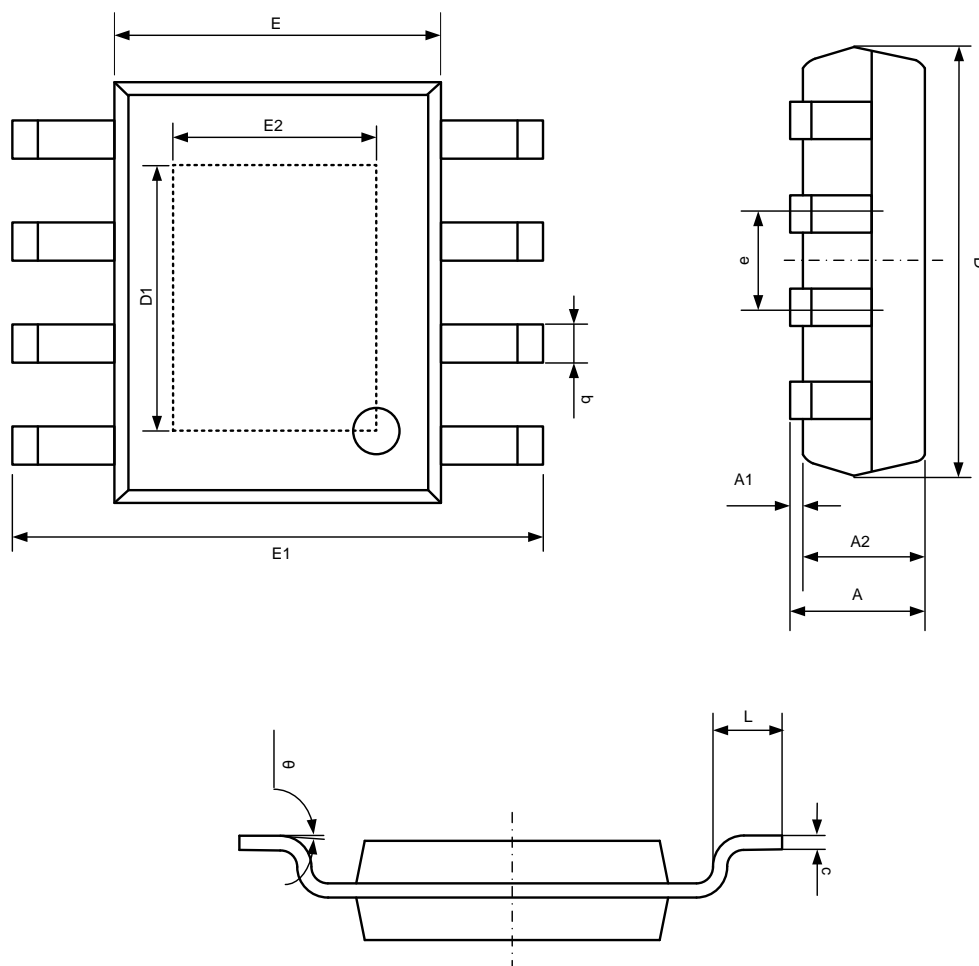


Figure 3

■ Package Information

● ESOP8



| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|----------|---------------------------|-------|----------------------|-------|
| | Min | Max | Min | Max |
| A | 1.350 | 1.750 | 0.053 | 0.069 |
| A1 | 0.050 | 0.150 | 0.002 | 0.006 |
| A2 | 1.350 | 1.550 | 0.053 | 0.061 |
| b | 0.330 | 0.510 | 0.013 | 0.020 |
| c | 0.170 | 0.250 | 0.007 | 0.010 |
| D | 4.700 | 5.100 | 0.185 | 0.200 |
| D1 | 3.202 | 3.420 | 0.126 | 0.134 |
| E | 3.8000 | 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° |