

1A Compatible With the USB Interface, Linear Battery Management Chip

■ 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.

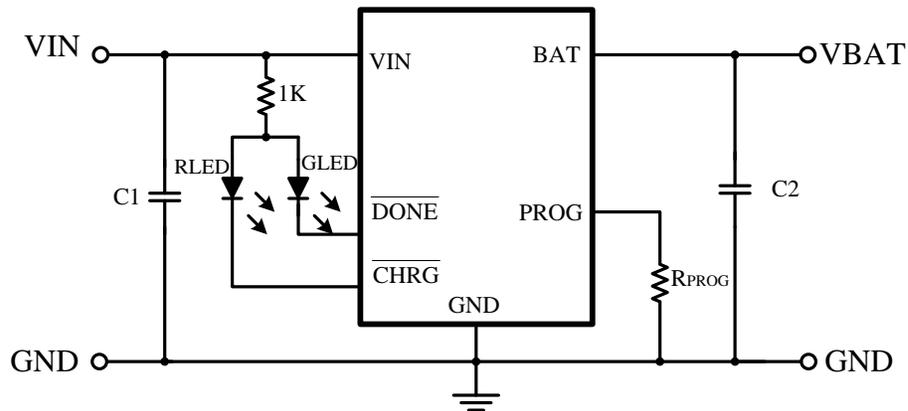
Thermal modulation circuit can control the internal chip temperature in a safe range when the device power dissipation be relatively large or the ambient temperature be higher.

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 0.1 μ A. 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=4.7 μ F, C2=10 μ F, IBAT = (V_{PROG}/R_{PROG})*1000

■ Features

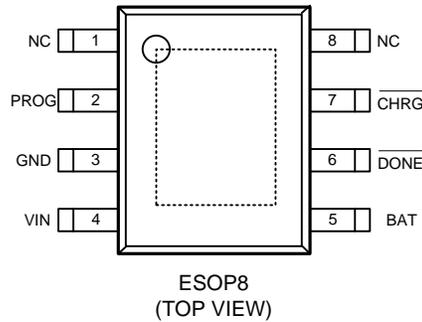
- Programmable charge current up to 1A
- No MOSFET, sense resistor or blocking diode required
- Complete linear charger in small package for single cell lithium-ion batteries
- Constant-current/constant-voltage operation with thermal regulation to maximize charge rate without risk of overheating
- Charges 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
- 40 μ A 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

XT2052①②③④⑤-⑥

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
⑥	Packing Material Type	G	Green epoxy molding compound

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

■ PINs Function Description

- **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:

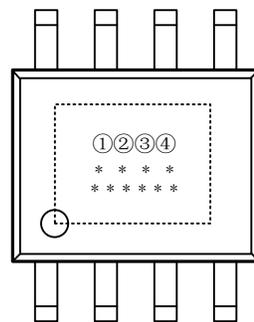
$$I_{BAT} = (V_{PROG}/R_{PROG}) \times 1000$$

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 25uA. This port floating voltage is about 2.4V. If supply this port voltage more than floating 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 1uF 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 2uA.
- **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



ESOP8
(TOP VIEW)

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

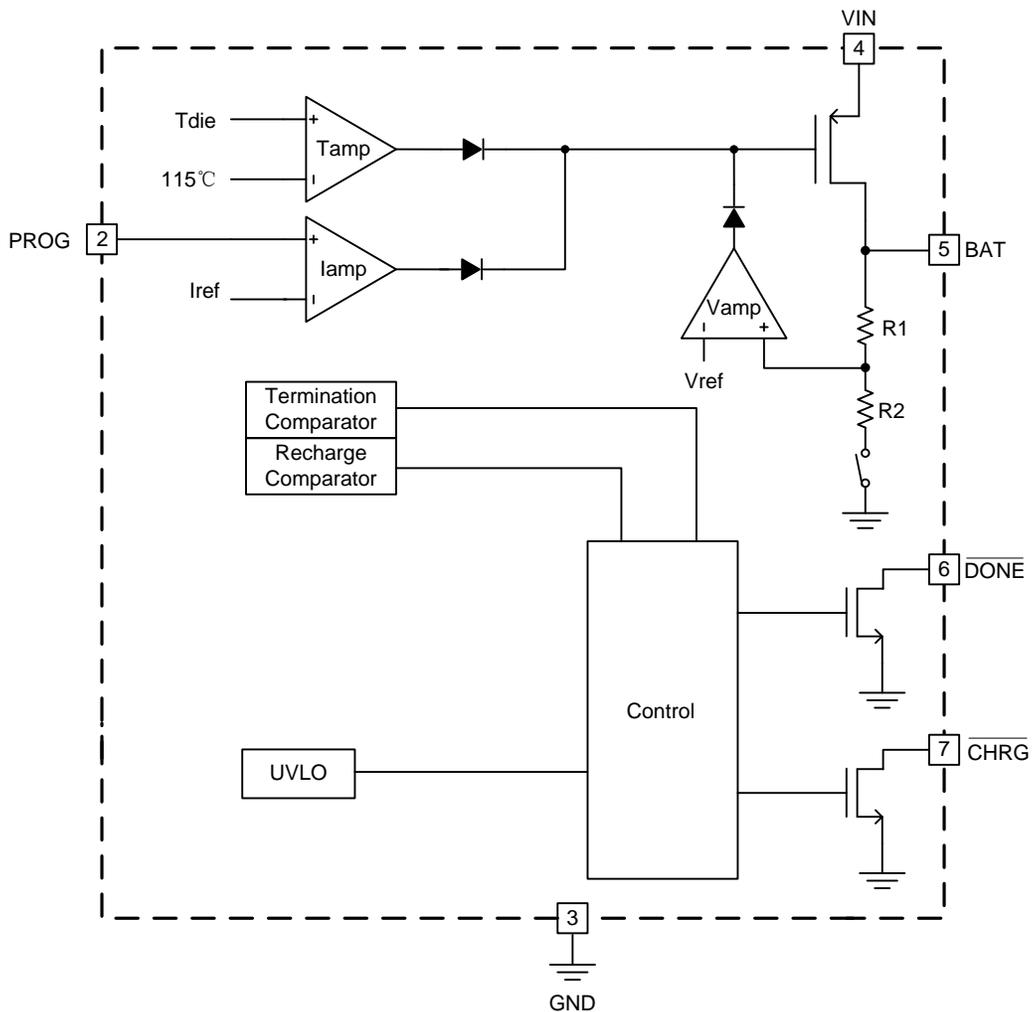
The second line and the third line stand for the company's quality tracking information.

■ Absolute Maximum Ratings

Parameter	Symbol	Maximum Rating	Unit
Input Supply Voltage	VIN	-0.3~+7	V
PROG pin Voltage	Vprog	-0.3~VIN+0.3	
BAT pin Voltage	Vbat	-0.3~7	
$\overline{\text{DONE}}$ pin Voltage	Vdone	-0.3~+7	
$\overline{\text{CHRG}}$ pin Voltage	Vchrg	-0.3~+7	
BAT pin Current	Ibat	1500	mA
PROG pin Current	Iprog	1500	μA
Operating Ambient Temperature	Topa	-40~+85	°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, IBAT=40mA	4.16	4.2	4.25	V
BAT pin Current	Ibat	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	Itrikl	Vbat<Vtrikl, R _{PROG} =2k	90	100	110	mA
Trickle charge Threshold Voltage	Vtrikl	R _{PROG} =10K, Vbat Rising	2.8	2.9	3.0	V
Trickle voltage hysteresis voltage	Vtrhys	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	Vmsd	PROG pin rising	1.15	1.21	1.30	V
		PROG pin falling	0.9	1.0	1.1	V
VIN-Vbat Lockout Threshold voltage	Vasd	Vin from low to high	70	100	140	mV
		Vin from high to low	5	30	50	mV
C/10 Termination Current Threshold	Iterm	R _{PROG} =10k	8	10	12	mA
		R _{PROG} =2k	40	50	65	mA
PROG pin Voltage	Vprog	R _{PROG} =10k, Current mode	0.90	1.0	1.1	V
CHRG pin Output low voltage	Vdone	Idone=5mA	-	0.35	0.6	V
CHRG pin Output low voltage	Vchrg	Ichrg=5mA	-	0.35	0.6	V
Recharge Battery threshold Voltage	Δ Vrecg	VFLOAT - VRECHRG	-	150	200	mV

■ Application Information

● Set the charge current

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

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: $R_{PROG} = 1000V/0.5A = 2K\Omega$

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

● 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, USB interface, Scotty diode D1 prevents the consumption of energy through the 1K resistor.

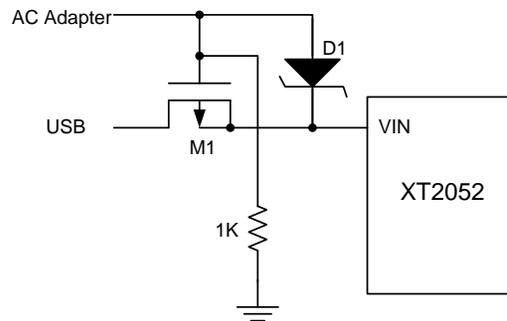


Figure1. While using the AC adapter and USB interfaces

● 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:

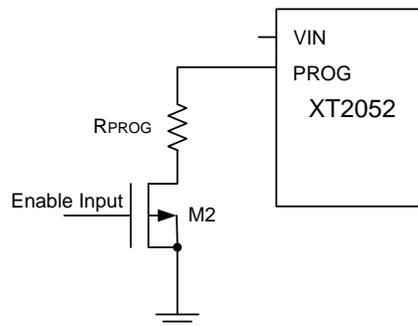


Figure 2. Enabel the charging system

● 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. When charging, CHRG is low; DONE to indicate the state of the charging end, 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 is not connected, the charger will quickly charge the output capacitor to the constant voltage value. Then the power MOSFET is been turn off, and the BAT pin voltage will slowly down to recharge threshold. so the BAT pin voltage is a 150mv ripple waveform. When the 4.7uF capacitor is connected with the BAT pin , the pulse period of the CHRG pin is about 2Hz.

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

State	Charge	Full	Without Battery	Error
CHRG	Always on	Always off	Flashing	Always off
DONE	Always off	Always on	Flashing	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 VIN 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 $0.5 * 1.2 = 0.6V$. The XT2052 real operating voltage is 4.4V. Thus, in this state, $(V_{IN} - V_{BAT}) * 1.2 < 1.2W$, 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.

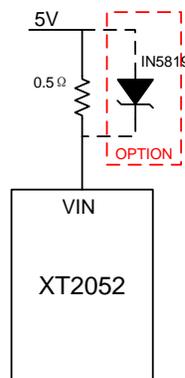
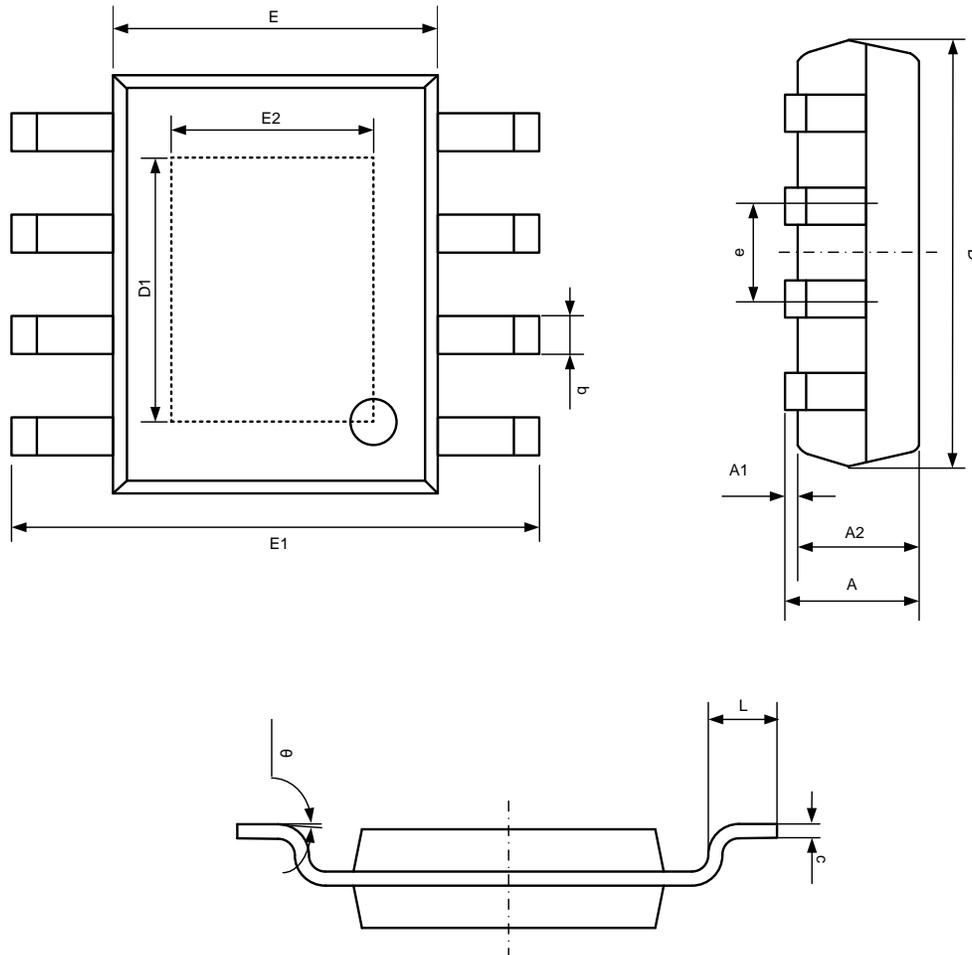


Figure 3

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°