# 1A Is Compatible With The USB Interface, Linear Battery Management Chip

## ■ General Description

The LN2052 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. LN2052 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. Charge current set by an external resistor.

When the input voltage (AC adapter or USB power supply) power is lost, LN2052 automatically enters a low power sleep mode, then the battery current consumption is less than 3μA. 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.LN2052 uses thermally enhanced 8-pin small outline package SOP-8/PP or MSOP-8/PP.

## ■ Package

- **ESOP8**
- **EMSOP8**

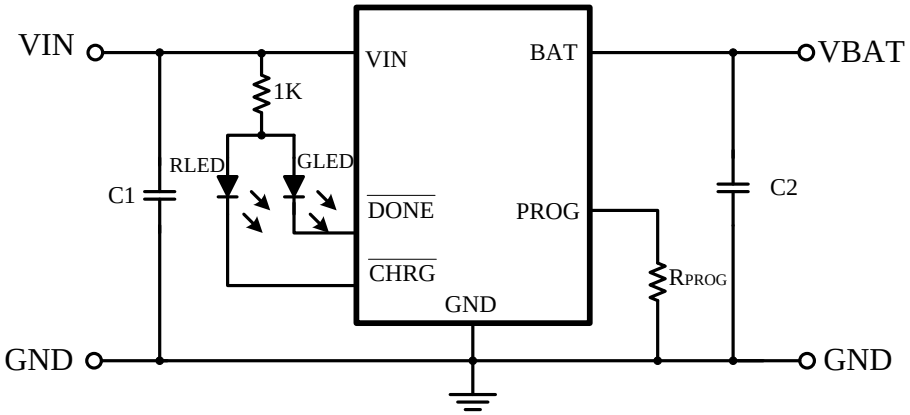
## ■ Applications

- Mobile phones
- Digital Cameras
- MP4 Player
- Bluetooth applications
- Electronic Dictionary
- portable devices
- all kinds of charger

## ■ 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
- 25μA supply current in shutdown
- 2.9V trickle charge threshold
- Soft-Start limits inrush current
- Output with protection against anti-irrigation
- Available in ESOP8 orEMSOP8 Package

## ■ Typical Application Circuit



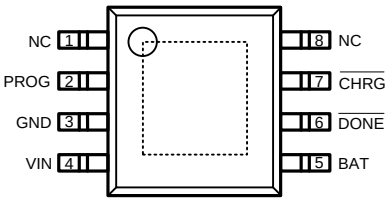

注：C1=4.7uF，C2=10uF，IBAT = ($V_{PROG}$/$R_{PROG}$)*1000

## ■ Ordering Information

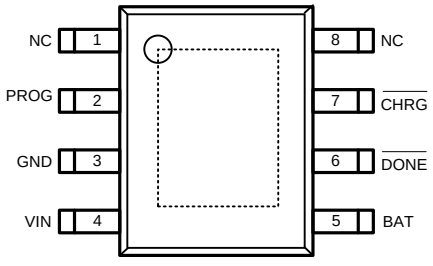
**LN2052①②③④⑤**

| 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 | SOP-8/PP |
| | | Q | MSOP-8/PP |
| ⑤ | Device Orientation | R | positive |
| | | L | negative |

## ■ Pin Configuration




EMSOP8
(TOP VIEW)




ESOP8
(TOP VIEW)

## ■ Pin Assignment

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

## ■ Pin Function

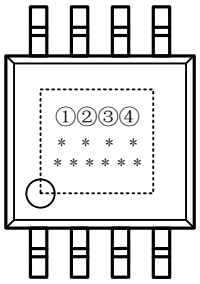
- **NC (Pin 1 and Pin 8):** No Connected.
- **PROG (Pin 2):** Charge current programming, charge current monitoring and close pin. Charge current is controlled by a resistor of precision of 1%to the ground. In the constant charge current state, this port provides 1V voltage. In all conditions, this port charge current can be calculated using the following formula:

  $$IBAT = (V_{PROG}/R_{PROG}) \times 1250$$

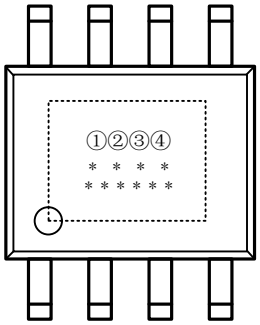
  PROG port can also be used to turn off the charger. Resistance to side with the separation of programming can pull the 3uA current source to increase PROG port voltage. When the suspension reached the limit voltage 1.21V, the device enters stop state, after charging the input current drop to 25A. This 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 combinating PROG pin to the ground, the charger will back to normal.
- **GND (Pin 3):** Ground terminal
- **VIN (Pin 4):** Supply positive input voltage. Power supply for the charger. VCC can be 4.25V to 6.5V and must have at least 1F bypass capacitor. If the BAT pin voltage of VCC down to within 30 mV, LN2052 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 power 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.
- **EXPOSED PAD( Pin 9):** Connect to ground or No Connected.

## ■ Marking Rule

- **ESOP8/EMSOP8**




EMSOP8
(TOP VIEW)




ESOP8
(TOP VIEW)

**① Represents the product name**

| Symbol | Description |
|---|---|
| 2 | LN2052◆◆◆◆◆ |

**② Represents the continuous charging type**

| Symbol | Description |
|---|---|
| R | No trickle charge function |
| S | Have trickle charge function |

**③ Represents the output voltage**

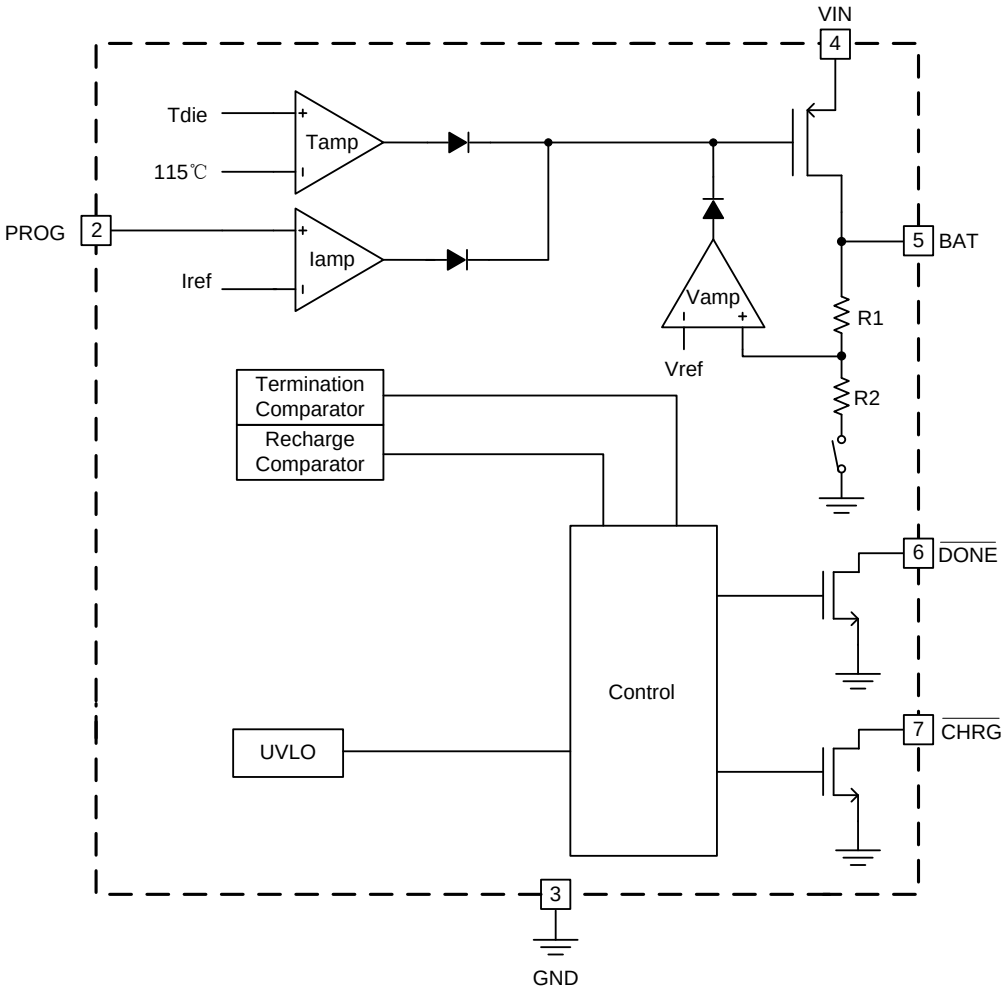
| Symbol | Voltage/V |
|---|---|
| A | 4.0 |
| B | 4.05 |
| C | 4.1 |
| D | 4.15 |
| E | 4.2 |
| F | 4.25 |

**④ Represents the package and reel tape type**

| Symbol | Description |
|---|---|
| S | ESOP8, front |
| Q | EMSOP8, front |
| R | ESOP8, back |
| P | EMSOP8, back |

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

## ■ Block Diagram




## ■ Absolute Maximum Ratings

| Parameter | Symbol | Maximum Rating | Unit |
|---|---|---|---|
| Input Supply Voltage | $V_{cc}$ | $V_{SS}$-0.3～$V_{SS}$+7 | V |
| PROG pin Voltage | Vprog | $V_{SS}$-0.3～$V_{cc}$+0.3 | |
| BAT pin Voltage | Vbat | Vss-0.3～6 | |
| DONE pin Voltage | Vdone | $V_{SS}$-0.3～$V_{SS}$+7 | |
| CHRG pin Voltage | Vchrg | $V_{SS}$-0.3～$V_{SS}$+7 | |
| BAT pin Current | Ibat | 1500 | mA |
| PROG pin Current | Iprog | 1500 | uA |
| 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.

## ■ Electrical Characteristics

**(TA=25℃ unless otherwise noted)**

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Input supply voltage | Vcc | - | 4.25 | - | 6.5 | V |
| Input supply current | Icc | Charge mode, $R_{PROG}$=10K | - | 200 | 2000 | μA |
| | | Standby mode | - | 200 | 500 | μA |
| | | Shutdown mode ($R_{PROG}$ not connected, Vcc<Vbat or Vcc<Vuv) | - | 25 | 50 | μA |
| Regulated Output Voltage | Vfloat | 0≤$T_A$≤85℃, IBAT = 40mA | 4.16 | 4.2 | 4.25 | V |
| BAT pin Current | Ibat | $R_{PROG}$ =10k,Current mode | 115 | 125 | 135 | mA |
| | | $R_{PROG}$=1k,Current mode | 1150 | 1250 | 1350 | mA |
| | | $R_{PROG}$ =830,Current mode | 1400 | 1500 | 1600 | mA |
| | | Standby mode, Vbat=4.2V | 0 | -2.5 | -6 | μA |
| | | Shutdown mode | - | 1 | -2 | μA |
| | | Sleep mode, Vcc=0V | - | 1 | -2 | μA |
| Trickle charge current | Itrikl | Vbat<Vtrikl, $R_{PROG}$ =2K | 40 | 65 | 90 | 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 |
| Vcc Undervoltage lockout Threshold | Vuv | From Vcc low to high | 3.7 | 3.8 | 3.93 | V |
| Vcc undervoltage lockout hysteresis | Vuvhys | - | 150 | 200 | 300 | mV |
| Manual shutdown threshold voltage | Vmsd | PROG pin rising | 1.4 | 1.45 | 1.5 | V |
| | | PROG pin falling | 1.2 | 1.25 | 1.3 | V |
| Vcc-Vbat Lockout Threshold voltage | Vasd | Vcc from low to high | 70 | 100 | 140 | mV |
| | | Vcc from high to low | 5 | 30 | 50 | mV |
| C/10 Termination Current Threshold | Iterm | $R_{PROG}$ =10k | 10 | 13 | 16 | mA |
| | | $R_{PROG}$ =2k | 40 | 65 | 90 | mA |
| PROG pin Voltage | Vprog | $R_{PROG}$ =10k, Current mode | 1.13 | 1.2 | 1.27 | V |
| CHRG pin Output low voltage | Vdone | Idone=5mA | - | 0.35 | 0.6 | μA |
| CHRG pin Output low voltage | Vchrg | Ichrg=5mA | - | 0.35 | 0.6 | V |
| Recharge Battery threshold Voltage | ΔVrecg | VFLOAT - VRECHRG | - | 150 | 200 | mV |

## ■ Application Information

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

LN2052 can not only use USB interface to charge the battery, users can also use a wall adapter to charge the battery. Figure 1 shows at the same time using the USB interface and the AC adapter to charge the battery through the LN2052 .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, Schottky diode D1 prevents the consumption of energy through the 1K resistor.

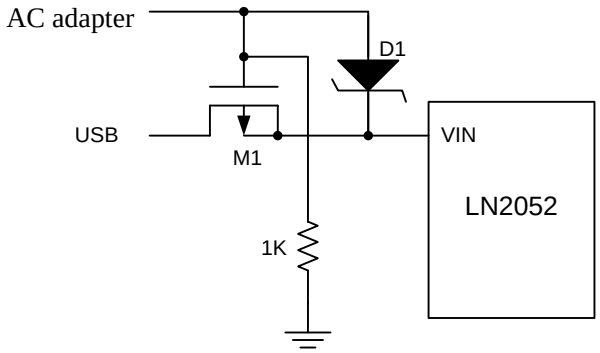



Figure 1. While using the AC adapter and USB interfaces

- Set the charge current

In constant-current mode, formula for calculating charge current: ICH = 1250V / $R_{PROG}$

ICH represents the charge current, units is ampere, RPROG represents PROG pin to ground resistance in ohms. For example, if you need 500 mA charges current, according to the following formula: RPROG = 1250V/0.5A = 2.5kΩ

In order to ensure good stability and temperature characteristics, RPROG 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: ICH = ($V_{PROG}$ / $R_{PROG}$) × 1250

- Enable design

By controlling whether the PROG pin resistor connected, users can reach close LN2052 function. Figure2:

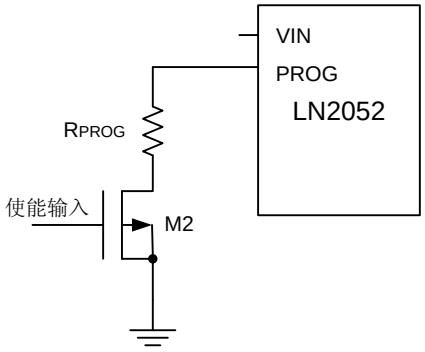



Figure 2. LN2052 Enable Design

- Open-drain output status indication

LN2052 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 the DONE pin status in each case:

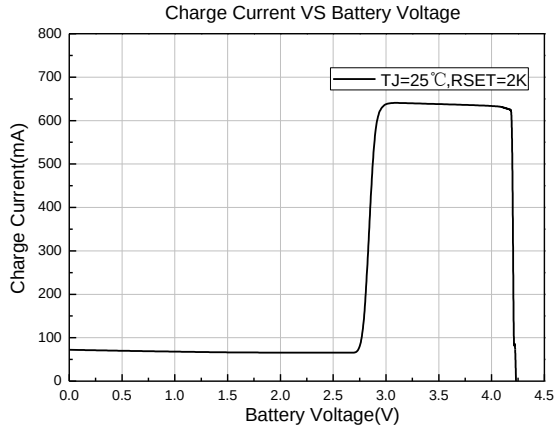
| State | Charge | Full | Without Battery | Error |
|---|---|---|---|---|
| CHRG | Always bright | Always off | Flashing | Always off |
| DONE | Always off | Always bright | Always bright | Always off |

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

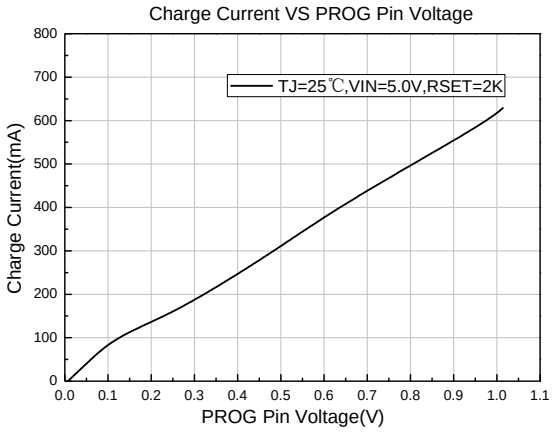
2. The error situation: Beyond the operating temperature range (temperature too high or too low), PROG side vacant, Vin <Vbat, Vin <3.8V and so on.

## ■ Typical Performance Characteristics

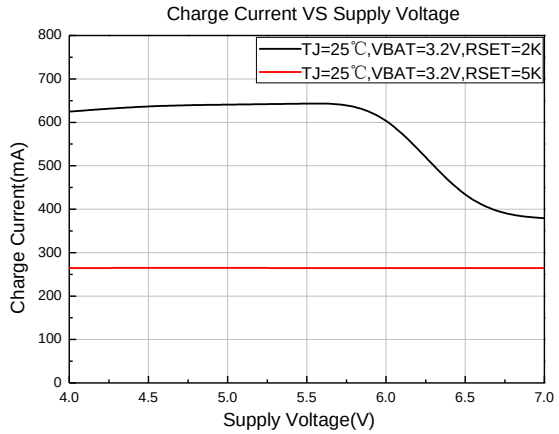
1. Charge Current VS Battery Voltage



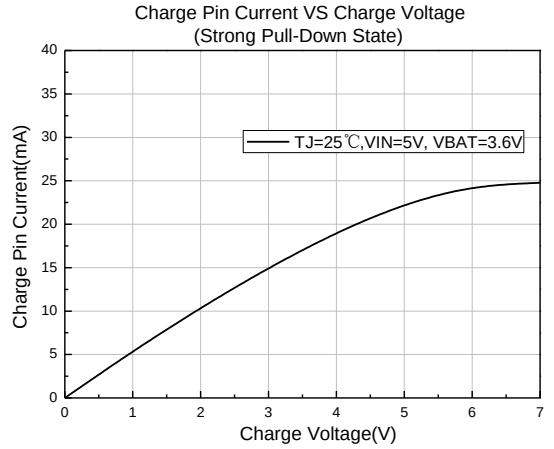

2. Charge Current VS PROG Pin Voltage



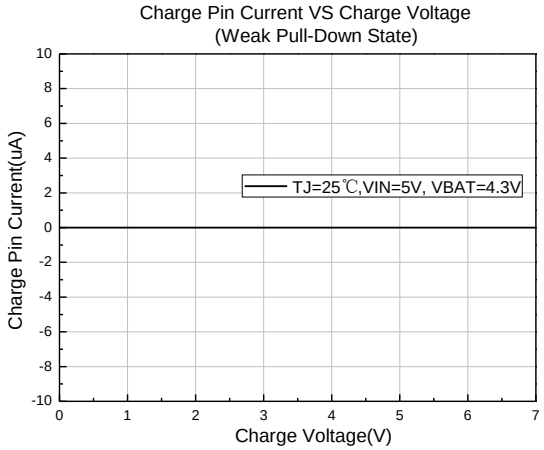

3. Charge Current VS Supply Voltage



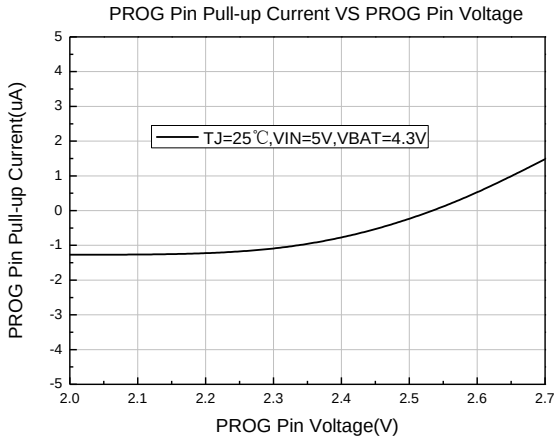

4. PROG Pin Pull-up Current VS PROG Pin Voltage



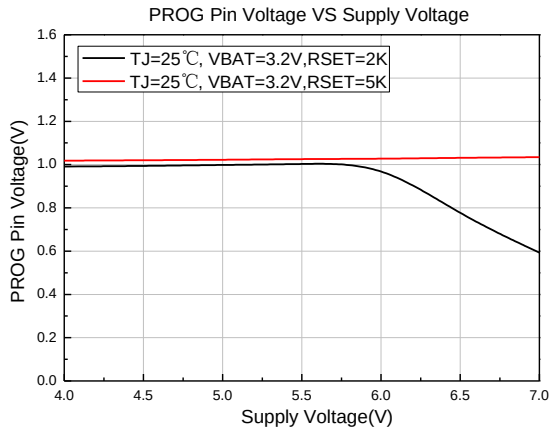

5. Charge Pin Current VS Charge Voltage (Weak Pull-Down State)



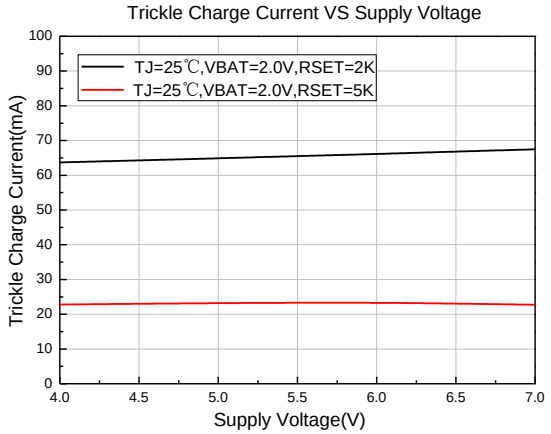

6. Charge Pin Current VS Charge Voltage (Strong Pull-Down State)



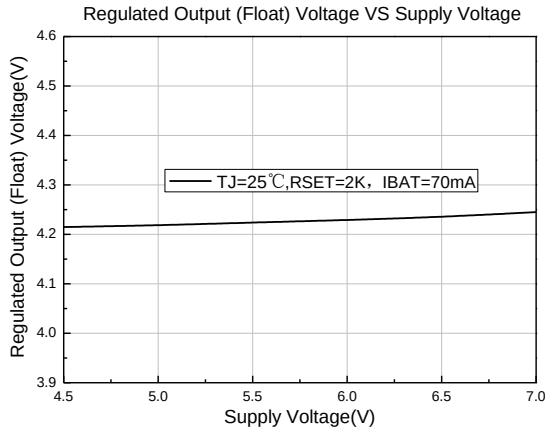
7. PROG Pin Voltage VS Supply Voltage



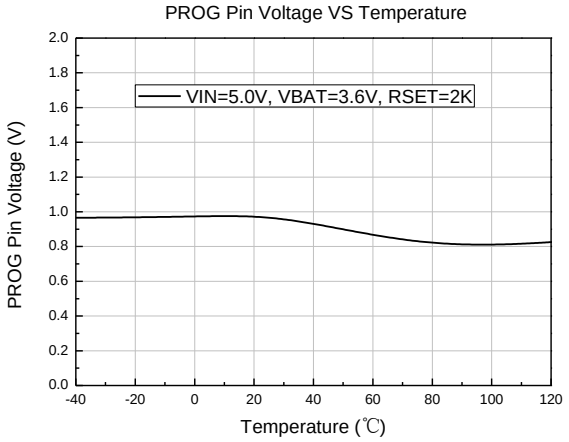

8. Trickle Charge Current VS Supply Voltage



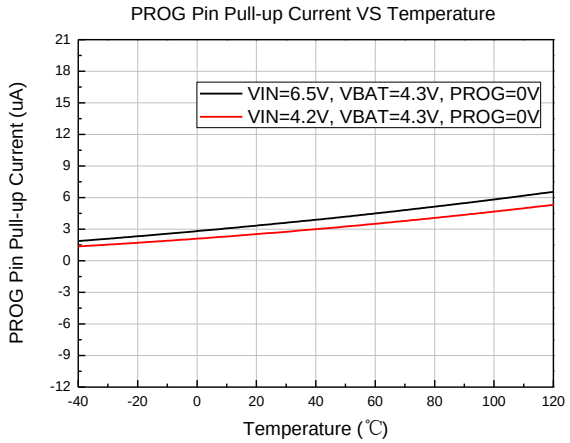

9. Regulated Output (Float) Voltage VS Supply Voltage



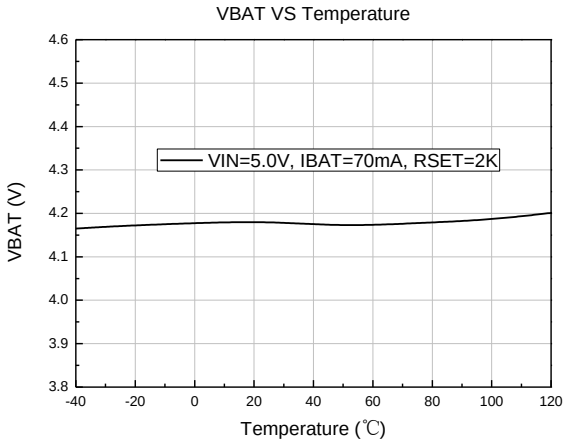

10. PROG Pin Voltage VS Temperature



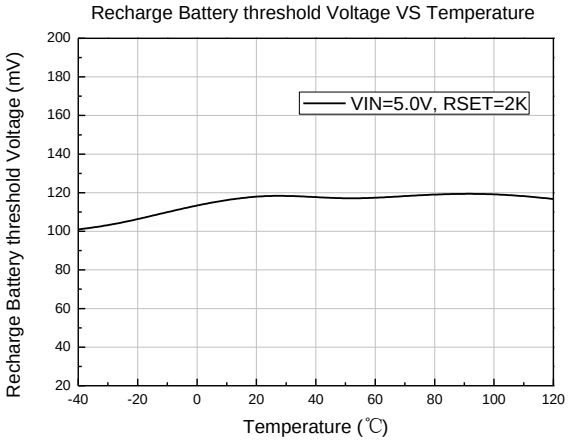

11. PROG Pin Pull-up Current VS Temperature



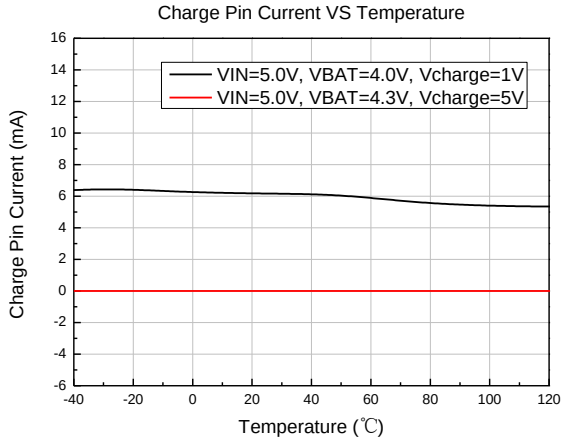

12. VBAT VS Temperature



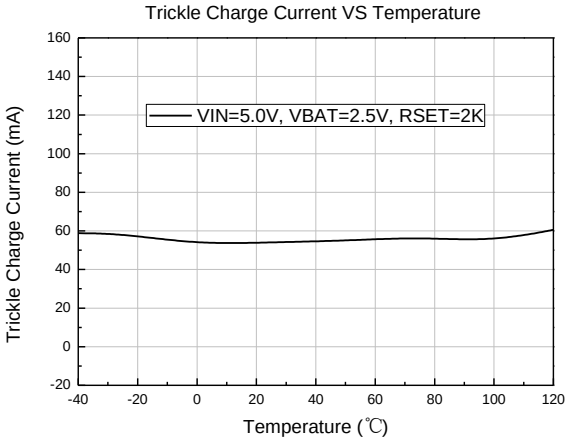
13. Recharge Battery threshold Voltage VS Temperature



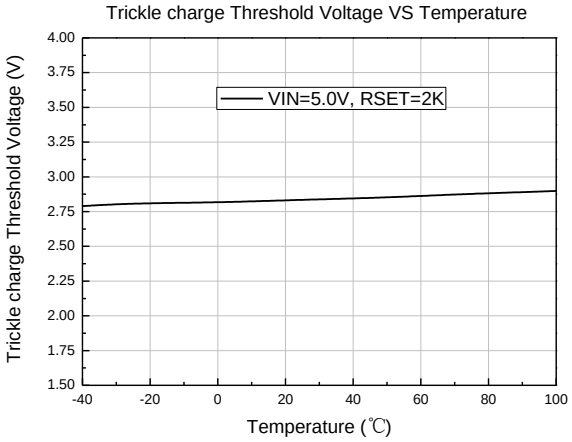

14. Charge Pin Current VS Temperature



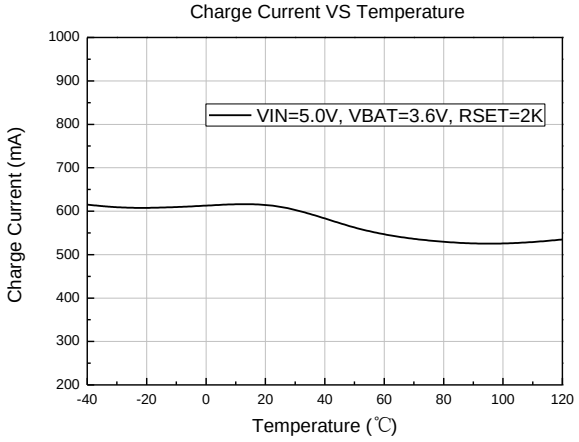

15. Trickle Charge Current VS Temperature



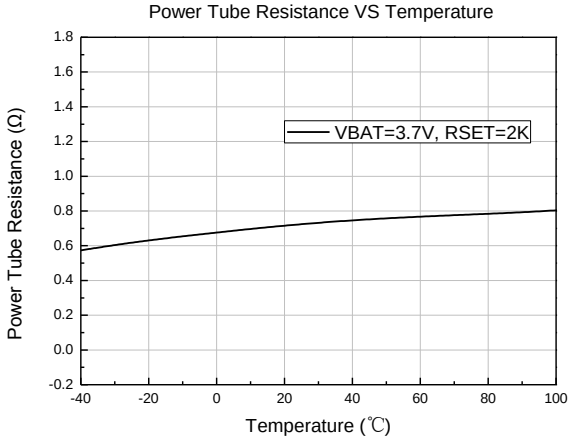

16. Trickle charge Threshold Voltage VS Temperature




17. Charge Current VS Temperature

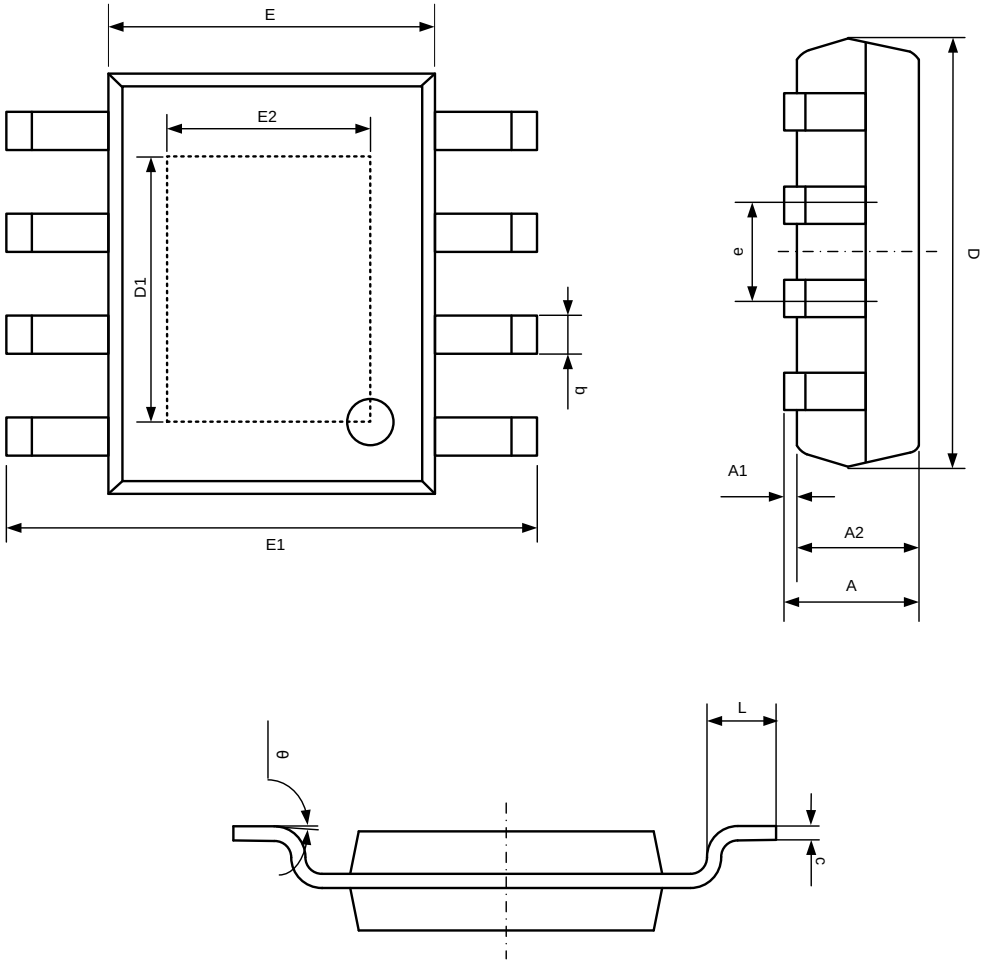



18. Power Tube Resistance VS Temperature



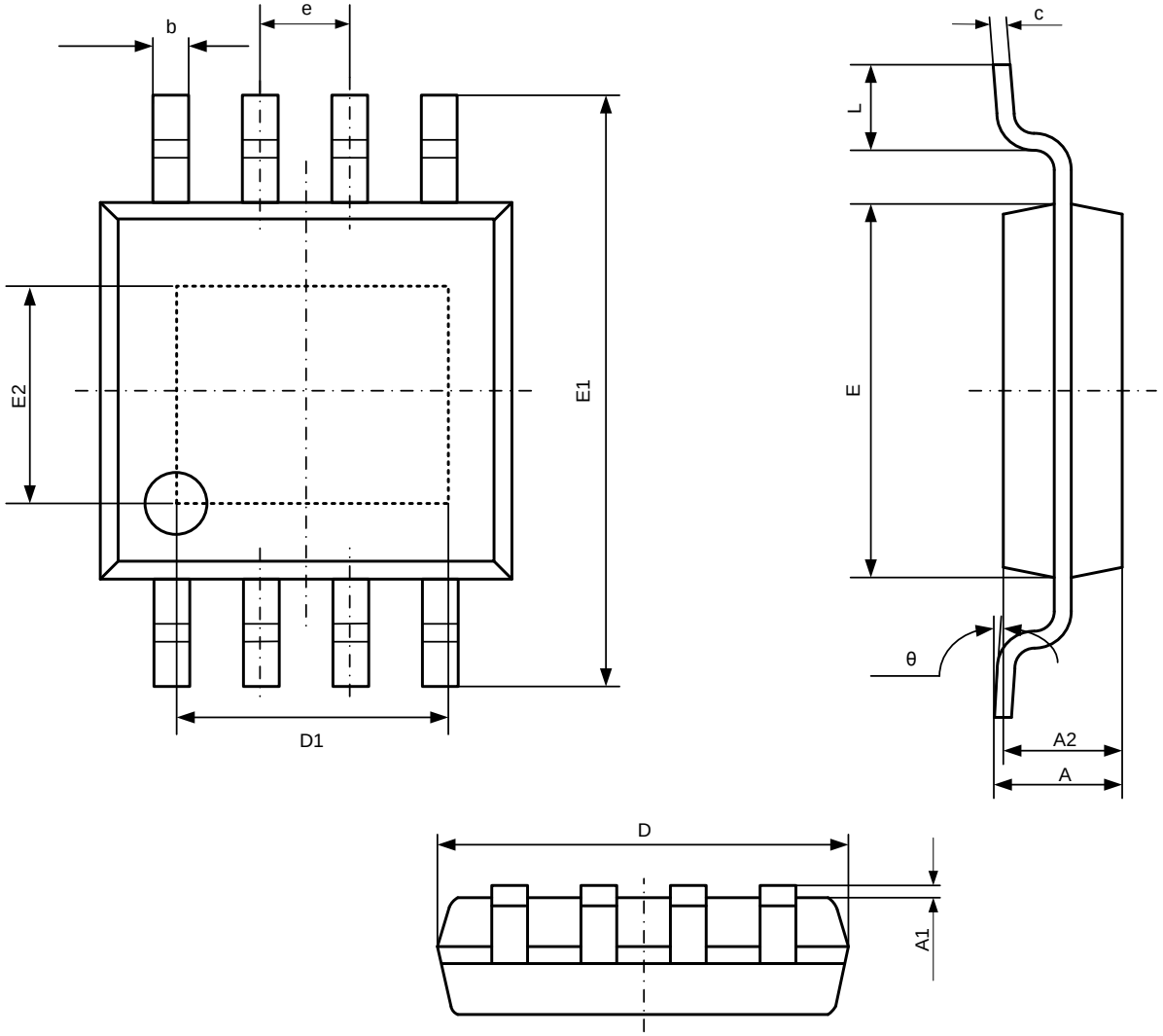
## ■ Package Information

- **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 | 3.800 | 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° |

- **EMSOP8**




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 0.820 | 1.100 | 0.032 | 0.043 |
| A1 | 0.020 | 0.150 | 0.001 | 0.006 |
| A2 | 0.750 | 0.950 | 0.030 | 0.037 |
| b | 0.250 | 0.380 | 0.010 | 0.015 |
| c | 0.090 | 0.230 | 0.004 | 0.009 |
| D | 2.900 | 3.100 | 0.114 | 0.122 |
| D1 | 1.700 | 1.900 | 0.067 | 0.075 |
| E | 2.900 | 3.100 | 0.114 | 0.122 |
| E1 | 4.750 | 5.050 | 0.187 | 0.199 |
| E2 | 1.450 | 1.650 | 0.057 | 0.065 |
| e | 0.650(BSC) | | 0.026(BSC) | |
| L | 0.400 | 0.800 | 0.016 | 0.031 |
| θ | 0° | 6° | 0° | 6° |