

Standalone Linear Li-Ion Battery Charger With Thermal Regulation In SOT

Description

The AP5054 is a complete constant current & constant voltage linear charger for single cell lithium-ion batteries. Its SOT package and low external component count make the AP5054 ideally suited for portable applications. Furthermore, the AP5054 is specifically designed to work within USB power specifications.

No external sense resistor is needed, and no blocking diode is required due to the internal MOSFET architecture. 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 AP5054 automatically terminates the charge cycle when the charge current drops to 1/10th the programmed value after the final float voltage is reached.

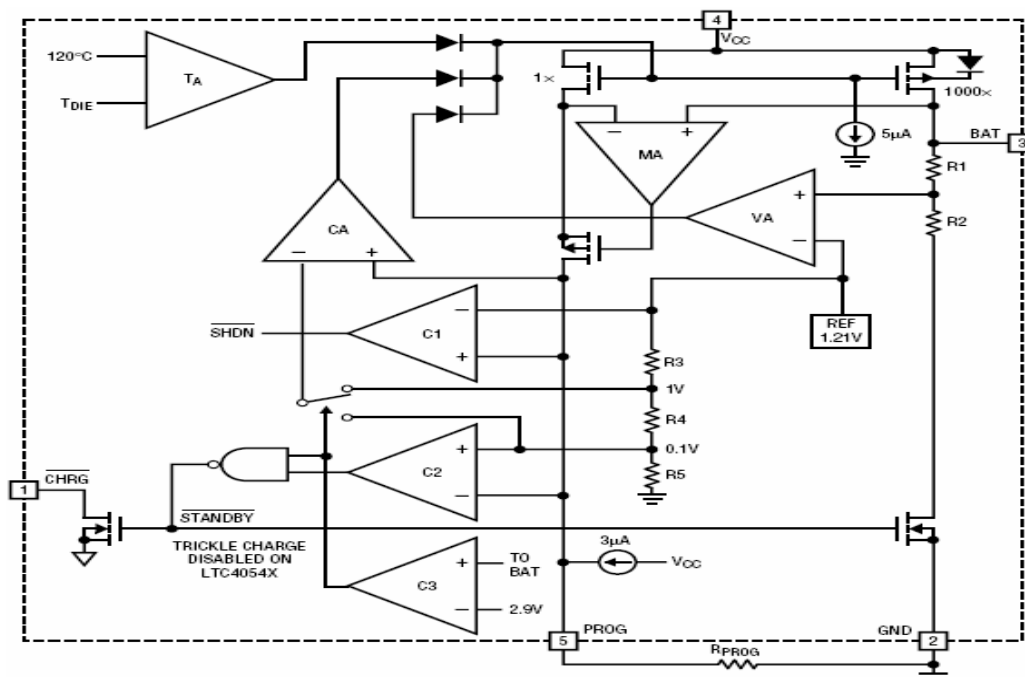
When the input supply (wall adapter or USB supply) is removed, the AP5054 automatically enters a low current state, dropping the battery drain current to less than 2uA. The AP5054 can be put into shutdown mode, reducing the supply current to 25uA.

Other features include charge current monitor, under-voltage lockout, automatic recharge and a status pin to indicate charge termination and the presence of an input voltage.

Features

- Programmable Charge Current Up to 800mA

Block Diagram



- No MOSFET, Sense Resistor or Blocking Diode Required
- Complete Linear Charger in SOT 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 $\pm 1\%$ Accuracy
- Charge Current Monitor Output for Gas Gauging
- Automatic Recharge
- Charge Status Output Pin
- C/10 Charge Termination
- 25uA Supply Current in Shutdown
- 2.9V Trickle Charge Threshold (AP5054)
- Soft-Start Limits Inrush Current
- Available in 5-Lead SOT-23 and SOT89 Package

Applications

- Cellular Telephones, PDAs, MP3 Players
- Charging Docks and Cradles
- Bluetooth Applications

Package

- SOT23-5
- SOT89-5

Absolute Maximum Ratings

| PARAMETER | SYMBOL | MAXIMUM RATING | UNIT |
|-------------------------------|-------------------|---|------|
| Input Supply Voltage | V _{cc} | V _{SS} -0.3~V _{SS} +10 | V |
| PROG pin Voltage | V _{prog} | V _{SS} -0.3~V _{cc} +0.3 | |
| BAT pin Voltage | V _{bat} | V _{SS} -0.3~7 | |
| CHAG pin Voltage | V _{chrg} | V _{SS} -0.3~V _{SS} +10 | |
| BAT pin Current | I _{bat} | 800 | mA |
| PROG pin Current | I _{prog} | 800 | 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

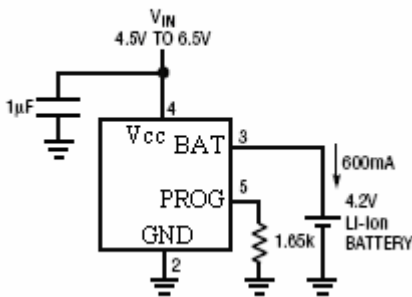
| Parameter | Symbol | CONDITION | MIN | TYP | MAX | UNIT |
|---|--------------------|---|-------|------|-------|-------|
| Input supply voltage | V _{cc} | | 4.25 | | 6.5 | V |
| Input supply current | I _{cc} | Charge mode, R _{prog} =10K | | 300 | 2000 | uA |
| | | Standby mode | | 200 | 500 | uA |
| | | Shutdown mode (R _{prog} not connected, V _{cc} <V _{bat} or V _{cc} <V _{uv}) | | 25 | 50 | uA |
| Regulated Output Voltage | V _{float} | 0°C, TA=25°C, I _{BAT} =40mA | 4.158 | 4.2 | 4.342 | V |
| BAT pin Current | I _{bat} | R _{prog} =10k, Current mode | 93 | 100 | 107 | mA |
| | | R _{prog} =2k, Current mode | 465 | 500 | 535 | mA |
| | | Standby mode, V _{bat} =4.2V | 0 | -2.5 | -6 | uA |
| | | Shutdown mode | | 1 | 2 | uA |
| | | Sleep mode, V _{cc} =0V | | 1 | 2 | uA |
| Trickle charge current | I _{trikl} | V _{bat} <V _{trikl} , R _{prog} =2k | 20 | 45 | 70 | mA |
| Trickle charge Threshold Voltage | V _{trikl} | R _{prog} =10K, V _{bat} Rising | 2.8 | 2.9 | 3.0 | V |
| Trickle voltage hysteresis voltage | V _{trhys} | R _{prog} =10k | 60 | 80 | 110 | mV |
| V _{cc} Undervoltage lockout Threshold | V _{uv} | From V _{cc} low to high | 3.7 | 3.8 | 3.93 | V |
| V _{cc} undervoltage lockout hysteresis | V _{uvhys} | | 150 | 200 | 300 | mV |
| Manual shutdown threshold voltage | V _{msd} | PROG pin rising | 1.15 | 1.21 | 1.30 | V |
| | | PROG pin falling | 0.9 | 1.0 | 1.1 | V |
| V _{cc} -V _{bat} Lockout Threshold voltage | V _{asd} | V _{cc} from low to high | 70 | 100 | 140 | mV |
| | | V _{cc} from high to low | 5 | 30 | 50 | mV |
| C/10 Termination Current | I _{term} | R _{prog} =10k | 0.085 | 0.10 | 0.115 | mA/mA |

| | | | | | | |
|------------------------------------|-------------------|-------------------------|-------|------|-------|-------|
| Threshold | | Rprog=2k | 0.085 | 0.10 | 0.115 | mA/mA |
| PROG pin Voltage | Vprog | Rprog=10k, Current mode | 0.93 | 1.0 | 1.07 | V |
| CHRG pin weak pull-down Current | Ichrg | Vchrg=5V | 8 | 20 | 35 | uA |
| CHRG pin Output low voltage | Vchrg | Ichrg=5mA | | 0.35 | 0.6 | V |
| Recharge Battery threshold Voltage | ΔV_{recg} | VFLOAT - VRECHRG | | 100 | 200 | mV |

Typical Application Circuit

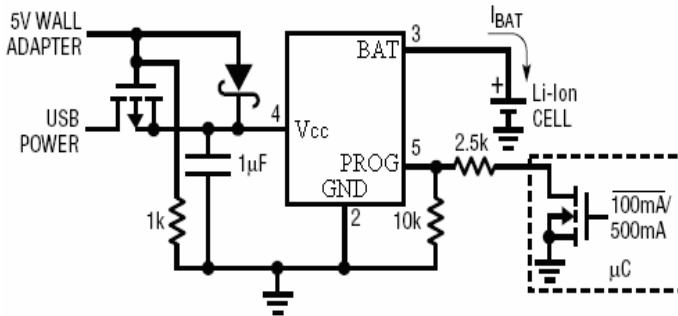
Basic circuit

600mA Single Cell Li-Ion Charger

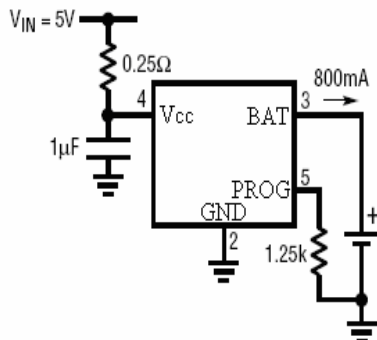


Typical circuit

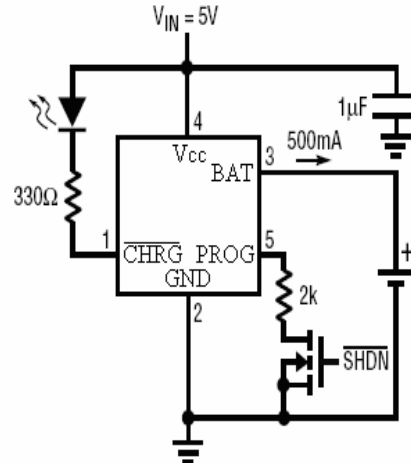
USB/WALL Adapter Power Li-Ion Charger



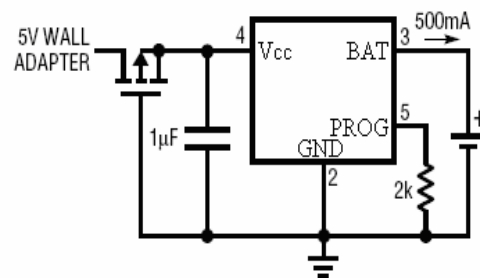
800mA Li-Ion Charger with External Power Dissipation



Full Featured Single Cell Li-Ion Charger

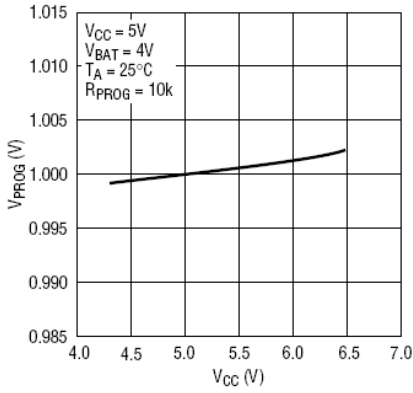


Basic Li-Ion Charger With Reverse Polarity Input Protection

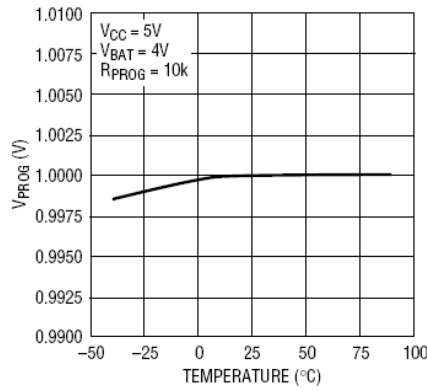


Typical Performance Characteristics

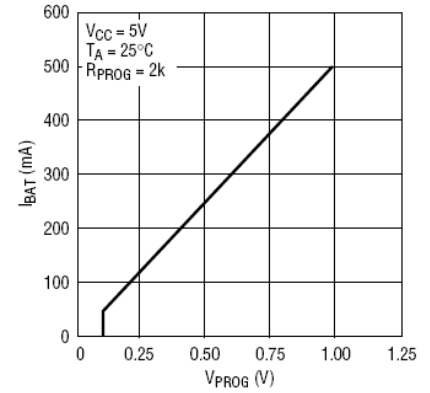
PROG Pin Voltage vs Supply Voltage (Constant Current Mode)



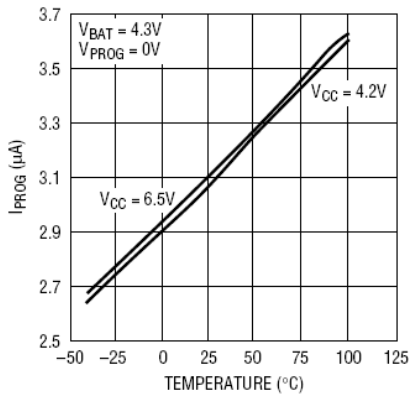
PROG Pin Voltage vs Temperature



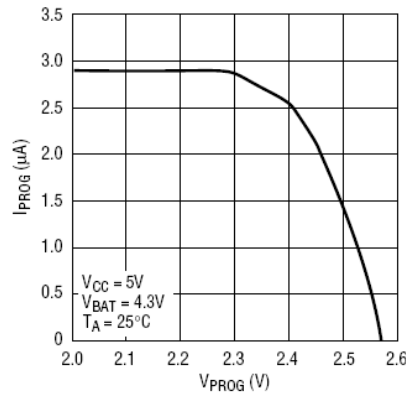
Charge Current vs PROG Pin Voltage



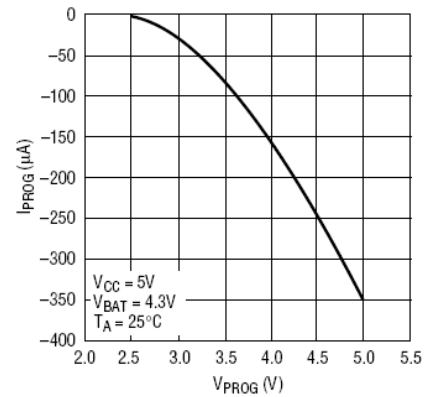
PROG Pin Pull-Up Current vs Temperature and Supply Voltage



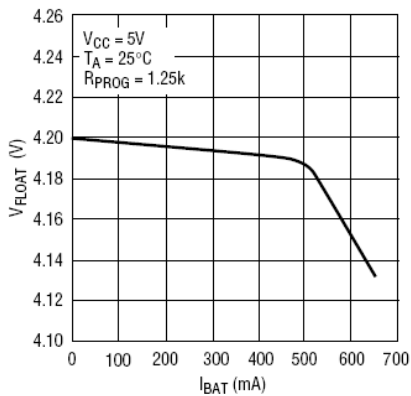
PROG Pin Current vs PROG Pin Voltage (Pull-Up Current)



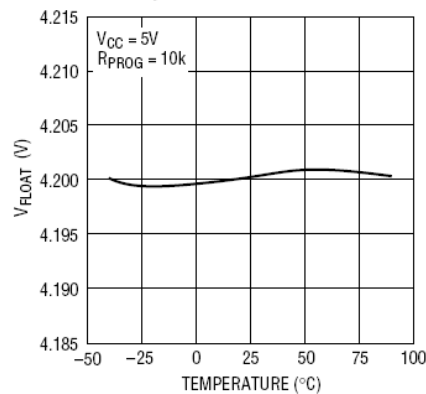
PROG Pin Current vs PROG Pin Voltage (Clamp Current)



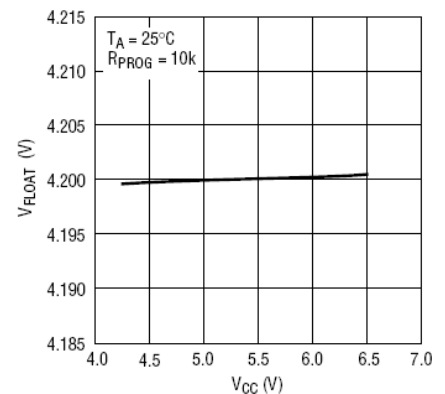
Regulated Output (Float) Voltage vs Charge Current



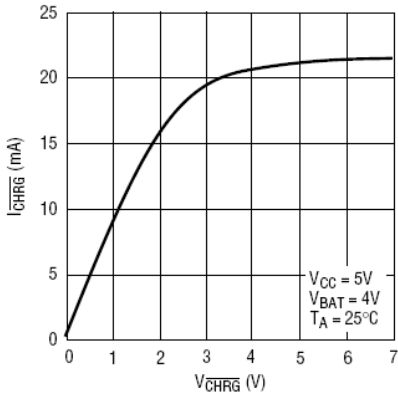
Regulated Output (Float) Voltage vs Temperature



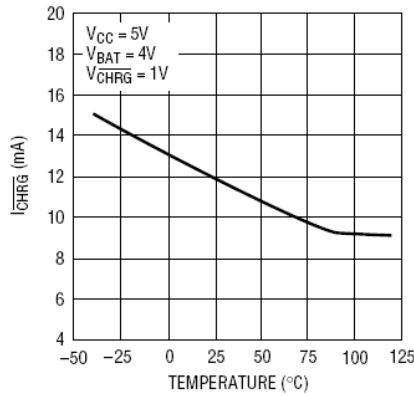
Regulated Output (Float) Voltage vs Supply Voltage



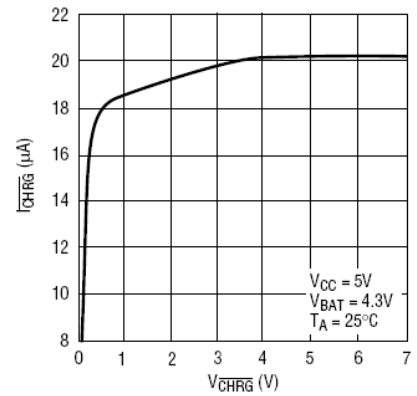
CHRG Pin I-V Curve (Strong Pull-Down State)



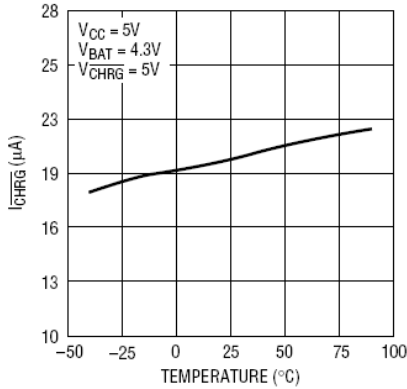
CHRG Pin Current vs Temperature (Strong Pull-Down State)



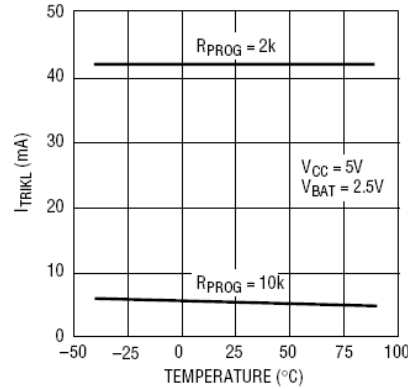
CHRG Pin I-V Curve (Weak Pull-Down State)



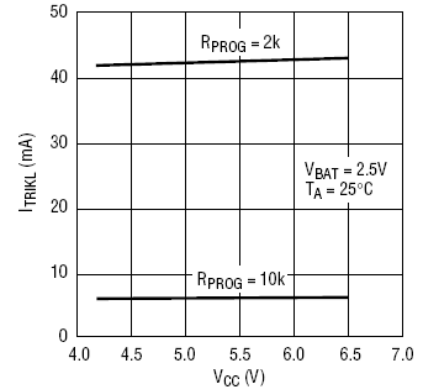
CHRG Pin Current vs Temperature (Weak Pull-Down State)



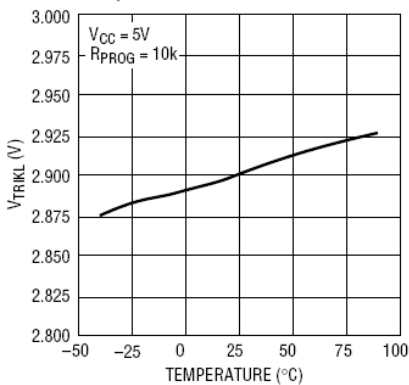
Trickle Charge Current vs Temperature



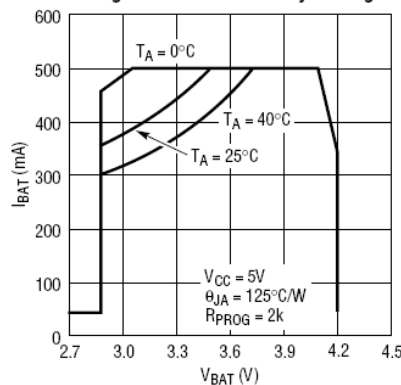
Trickle Charge Current vs Supply Voltage



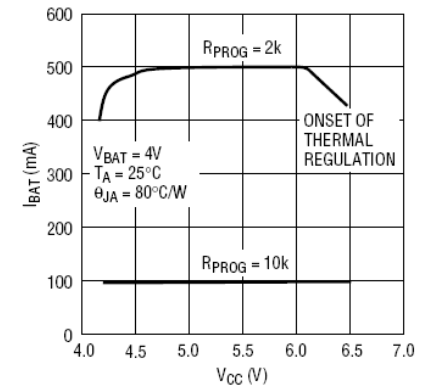
Trickle Charge Threshold vs Temperature



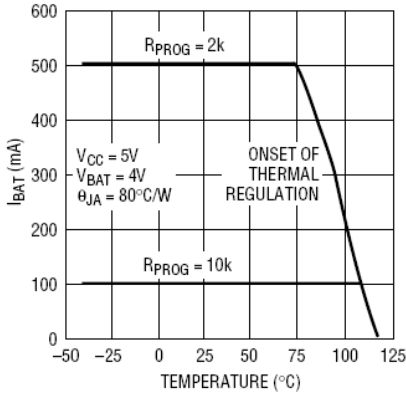
Charge Current vs Battery Voltage



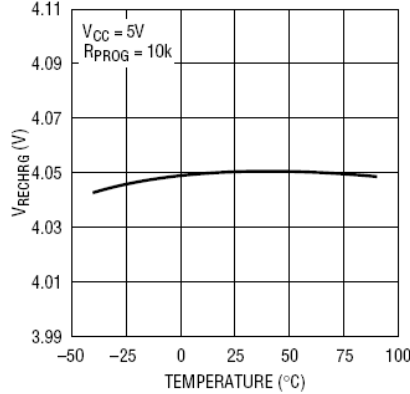
Charge Current vs Supply Voltage



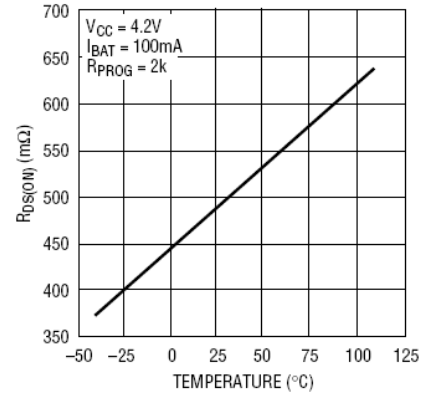
Charge Current vs Ambient Temperature



Recharge Voltage Threshold vs Temperature



Power FET "ON" Resistance vs Temperature



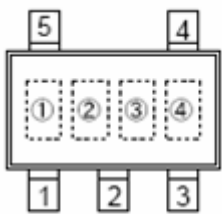
Ordering Information

AP5045①②③④⑤

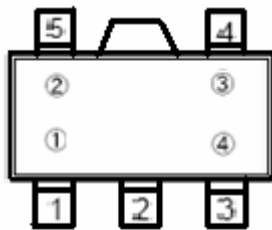
| DESIGNATOR | DESCRIPTION | SYMBOL | DESCRIPTION |
|------------|---|--------|------------------------------|
| ① | Type | X | Without trickle charge |
| | | Y | With trickle charge |
| ② | The first part of regulator Output Voltage | 0 | 4.0 |
| | | 1 | 4.1 |
| | | 2 | 4.2 |
| ③ | The second part of regulator Output Voltage | A | ②00 |
| | | B | ②25 |
| | | C | ②50 |
| | | D | ②75 |
| ④ | Packaging Types | M | SOT23-5 |
| | | P | SOT89-5 |
| ⑤ | Device Orientation | R | Embossed tape: Standard feed |
| | | L | Embossed tape: Reverse feed |

Marking

- SOT23-5, SOT89-5



SOT23-5
(TOP VIEW)



SOT89-5
(TOP VIEW)

① Represents the product name

| SYMBOL | PRODUCT NAME |
|--------|--------------|
| 2 | AP5054◆◆◆◆◆ |

② Represents the type of the trickle charge voltage

| SYMBOL | Product Series |
|--------|----------------|
| X | AP5054X◆◆◆◆◆ |
| Y | AP5054Y◆◆◆◆◆ |

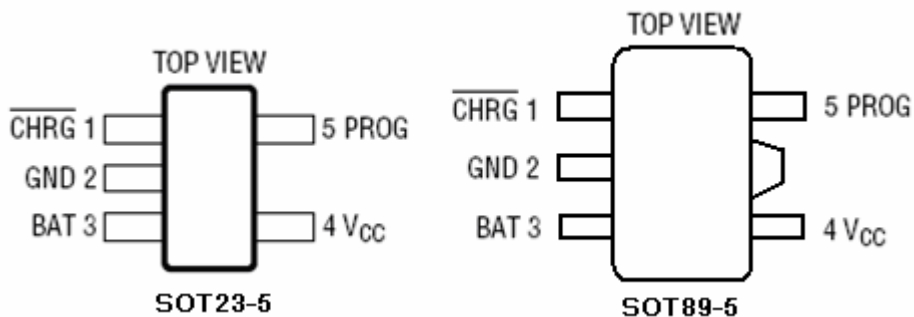
③ Represents the regulator output voltage

| SYMBOL | Voltage | | SYMBOL | Voltage |
|--------|---------|--|--------|---------|
| A | 4.0 | | H | 4.150 |
| B | 4.025 | | K | 4.175 |
| C | 4.05 | | L | 4.2 |
| D | 4.075 | | M | 4.225 |
| E | 4.1 | | N | 4.250 |
| F | 4.125 | | P | 4.275 |

④Represents the assembly lot no.

0 to 9, A to Z, reversed character of 0 to 9 and A to Z repeated(G,I,J,O,Q,W excepted)

Pin Configuration



Pin Assignment

| Pin Number | | Pin Name |
|------------|---------|----------|
| SOT23-5 | SOT89-5 | |
| 1 | 1 | CHRG |
| 2 | 2 | GND |
| 3 | 3 | BAT |
| 4 | 4 | VCC |
| 5 | 5 | PROG |

Pin Function

CHRG (Pin 1): 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 is connected to the CHRG pin, indicating an “AC present” condition. When the AP5054 detects an under voltage lockout condition, CHRG is forced high impedance.

GND (Pin 2): Ground.

BAT (Pin 3): Charge Current Output. Provides charge

current to the battery and regulates the final float voltage to 4.2V. An internal precision resistor divider from this pin sets the float voltage which is disconnected in shutdown mode.

VCC (Pin 4): Positive Input Supply Voltage. Provides power to the charger, VCC can range from 4.25V to 6.5V and should be bypassed with at least a 1uF capacitor. When VCC drops to within 30mV of the BAT pin voltage, the AP5054 enters shutdown mode, dropping IBAT to less than 2uA.

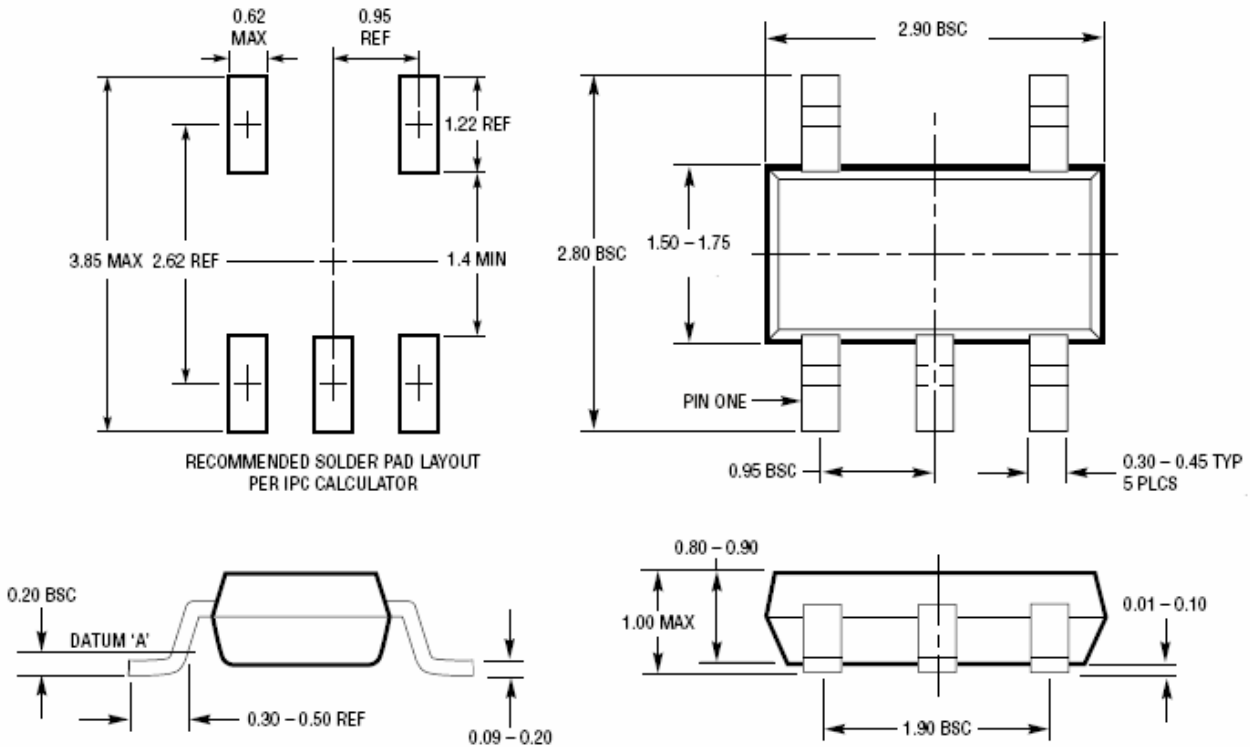
PROG (Pin 5): Charge Current Program, Charge Current Monitor and Shutdown Pin. The charge current is programmed by connecting a 1% resistor, RPROG, to ground. When charging in constant-current mode, this pin serves to 1V. In all modes, the voltage on this pin can be used to measure the charge current using the following formula:

$$IBAT = (VPROG/RPROG) \cdot 900$$

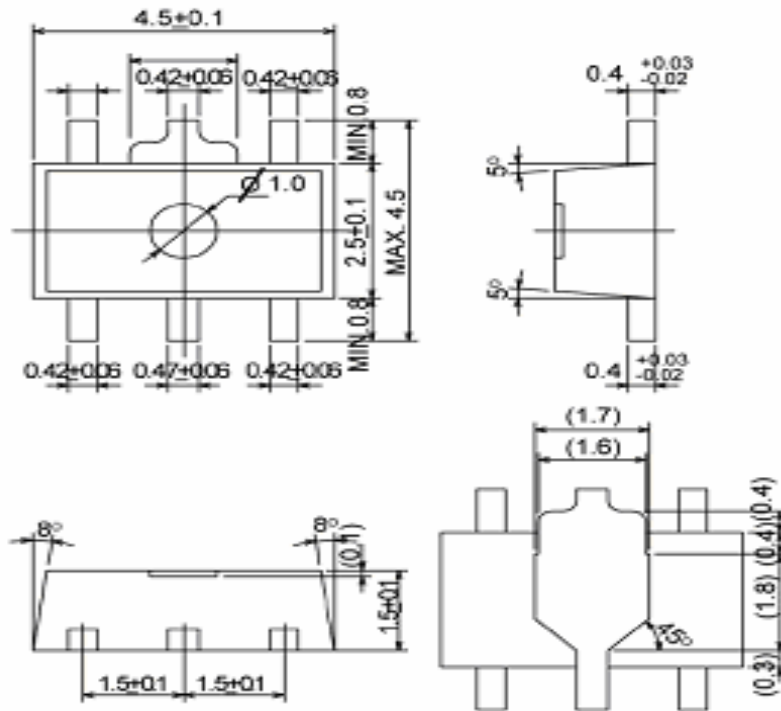
The PROG pin can also be used to shut down the charger. Disconnecting the program resistor from ground allows a 3uA current to pull the PROG pin high. When it reaches the 1.21V shutdown threshold voltage, the charger enters shutdown mode, charging stops and the input supply current drops to 25uA. This pin is also clamped to approximately 2.4V. Driving this pin to voltages beyond the clamp voltage will draw currents as high as 1.5mA. Reconnecting RPROG to ground will return the charger to normal operation.

Package Information

- SOT23-5



- SOT89-5



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