

## 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 1/10<sup>th</sup> the programmed value after the final float voltage is reached.

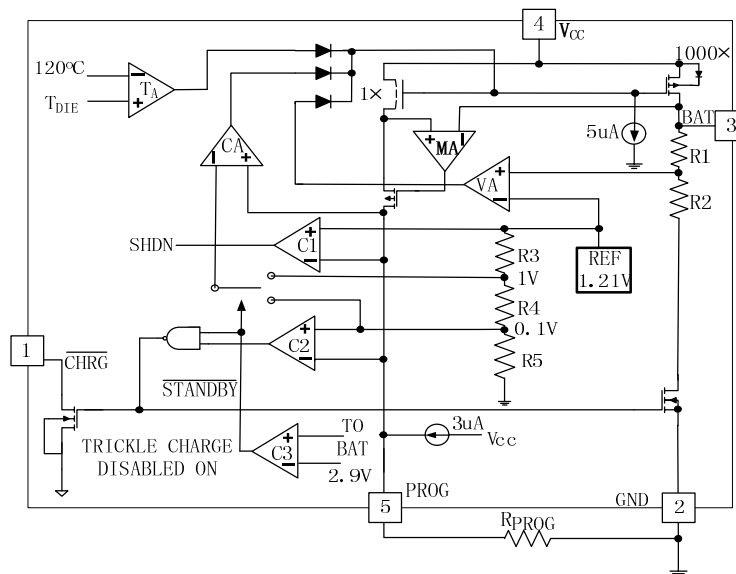
When the input supply (wall adapter or USB supply) is removed, the AP5054 automatically enters a low current state, dropping the battery drain current to less than 2uA. The AP5054 can be put into shutdown mode, reducing the supply current to 25uA.

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.

### Applications

- Cellular Telephones, PDAs, MP3 /MP4 Players

### Block Diagram



- Charging Docks and Cradles
- Bluetooth 、 GPS Applications

### Features

- Programmable Charge Current Up to 750mA
- 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
- Soft-Start Limits Inrush Current
- Available in 5-Lead SOT-23 Package

### Package

- SOT23-5L

## Absolute Maximum Ratings

PARAMETER	SYMBOL	MAXIMUM RATING	UNIT
Input Supply Voltage	V <sub>cc</sub>	V <sub>SS</sub> -0.3~V <sub>SS</sub> +7	V
PROG pin Voltage	V <sub>prog</sub>	V <sub>SS</sub> -0.3~V <sub>cc</sub> +0.3	
BAT pin Voltage	V <sub>bat</sub>	V <sub>SS</sub> -0.3~7	
CHAG pin Voltage	V <sub>chrg</sub>	V <sub>SS</sub> -0.3~V <sub>SS</sub> +7	
BAT pin Current	I <sub>bat</sub>	750	mA
PROG pin Current	I <sub>prog</sub>	750	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

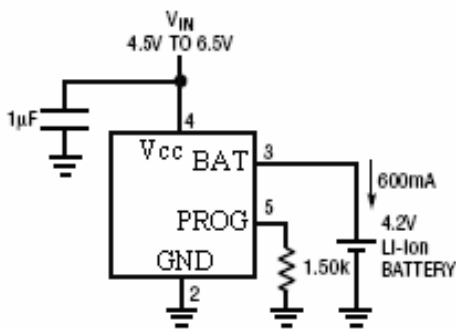
Parameter	Symbol	CONDITION	MIN	TYP	MAX	UNIT
Input supply voltage	V <sub>cc</sub>		4.25		6.5	V
Input supply current	I <sub>cc</sub>	Charge mode, R <sub>PROG</sub> =10K		350	2000	uA
		Standby mode		150	500	uA
		Shutdown mode(R <sub>PROG</sub> not connected, V <sub>cc</sub> <V <sub>bat</sub> or V <sub>cc</sub> <V <sub>uv</sub> )		30	50	uA
Regulated Output Voltage	V <sub>float</sub>	0°C ≤ T <sub>A</sub> ≤ 85°C, I <sub>BAT</sub> = 40mA	4.158	4.2	4.242	V
BAT pin Current	I <sub>bat</sub>	R <sub>PROG</sub> = 10k, Current mode	93	100	107	mA
		R <sub>PROG</sub> = 2k, Current mode	465	500	535	mA
		Standby mode, V <sub>bat</sub> =4.2V	0	-2.5	-6	uA
		Shutdown mode		1	2	uA
		Sleep mode, V <sub>cc</sub> =0V		0.3	2	uA
Trickle charge current	I <sub>trikl</sub>	V <sub>bat</sub> <V <sub>trikl</sub> , R <sub>prog</sub> =2k	20	45	70	mA
Trickle charge Threshold Voltage	V <sub>trikl</sub>	R <sub>PROG</sub> = 10K, V <sub>bat</sub> Rising	2.8	2.9	3.0	V
Trickle voltage hysteresis voltage	V <sub>trhys</sub>	R <sub>PROG</sub> = 10k	60	80	110	mV
V <sub>cc</sub> Undervoltage lockout Threshold	V <sub>uv</sub>	From V <sub>cc</sub> low to high	3.7	3.8	3.93	V
V <sub>cc</sub> undervoltage lockout hysteresis	V <sub>uvhys</sub>		150	200	300	mV
Manual shutdown threshold voltage	V <sub>msd</sub>	P <sub>ROG</sub> pin rising	1.15	1.25	1.30	V
		P <sub>ROG</sub> pin falling	0.9	1.0	1.1	V
V <sub>cc</sub> -V <sub>bat</sub> Lockout Threshold voltage	V <sub>asd</sub>	V <sub>cc</sub> from low to high	50	100	140	mV
		V <sub>cc</sub> from high to low	5	40	50	mV
C/10 Termination Current Threshold	I <sub>term</sub>	R <sub>PROG</sub> =10k	0.055	0.06	0.09	mA/mA
		R <sub>PROG</sub> =2k	0.08	0.10	0.11	mA/mA
PROG pin Voltage	V <sub>prog</sub>	R <sub>PROG</sub> = 10k, Current mode	0.93	1.0	1.07	V

CHRG pin weak pull-down Current	I <sub>chrg</sub>	V <sub>chrg</sub> =5V	8	15	35	uA
CHRG pin Output low voltage	V <sub>chrg</sub>	I <sub>chrg</sub> =5mA		0.35	0.6	V
Recharge Battery threshold Voltage	ΔV <sub>recg</sub>	V <sub>FLOAT</sub> - V <sub>RECHRG</sub>		100	200	mV

## Typical Application Circuit

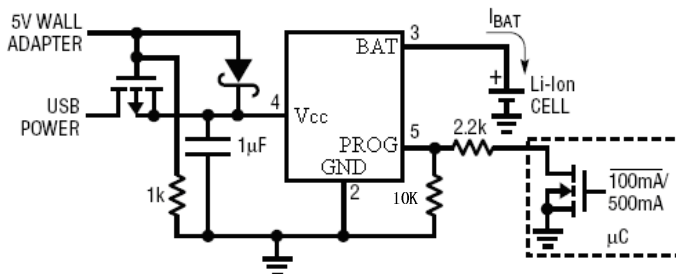
### Basic circuit

#### 600mA Single Cell Li-Ion Charger

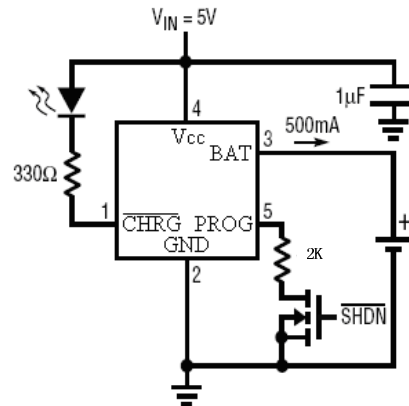


### Typical circuit

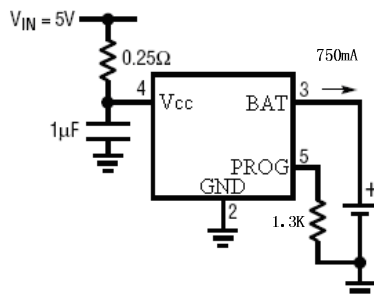
#### USB/WALL Adapter Power Li-Ion Charger



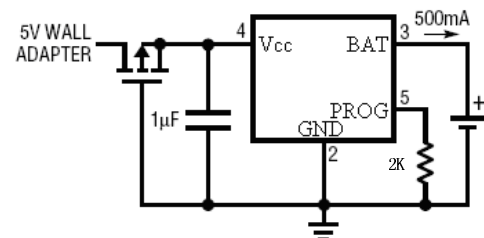
#### Full Featured Single Cell Li-Ion Charger



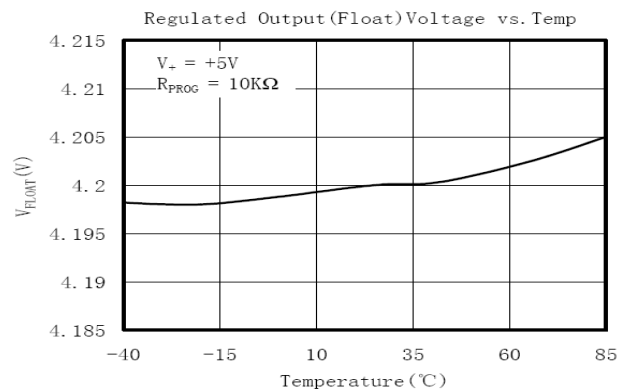
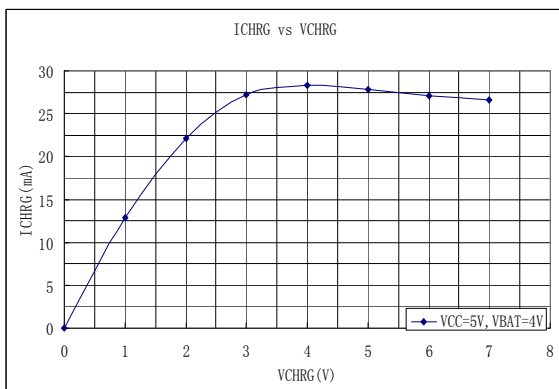
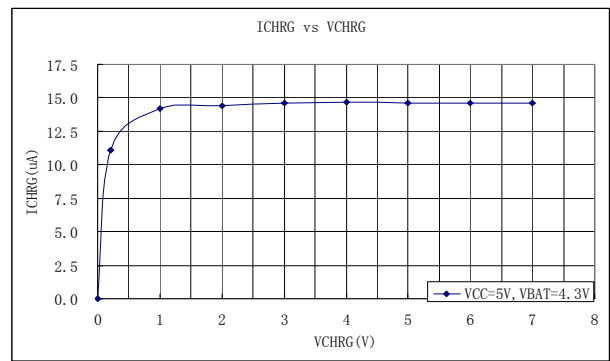
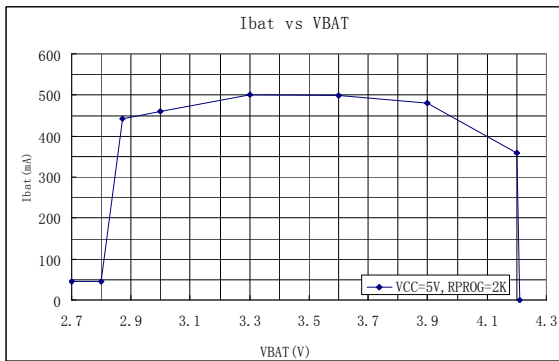
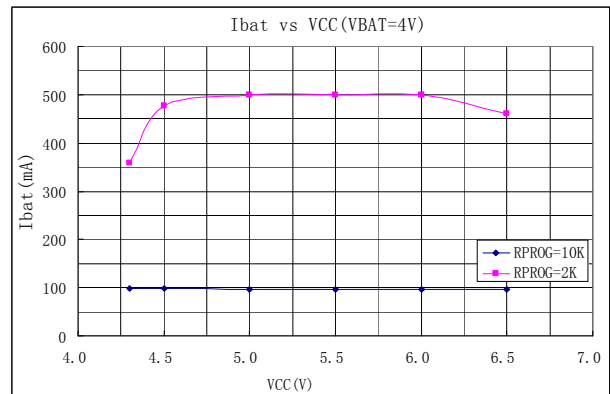
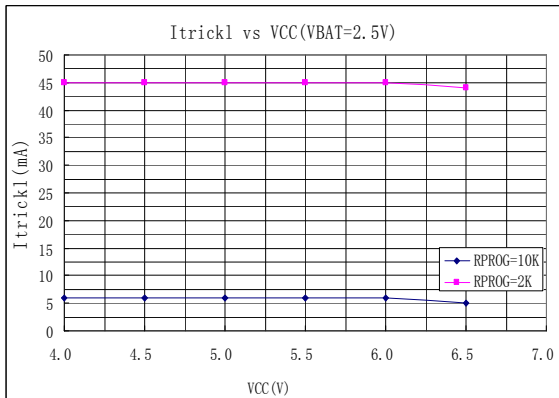
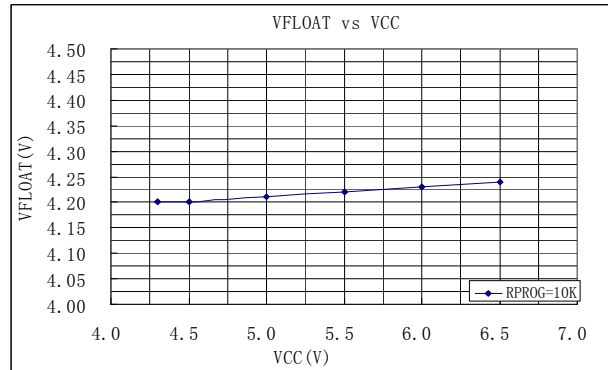
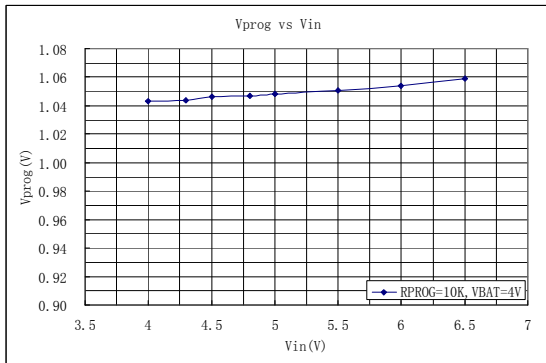
#### 800mA Li-Ion Charger with External Power Dissipation

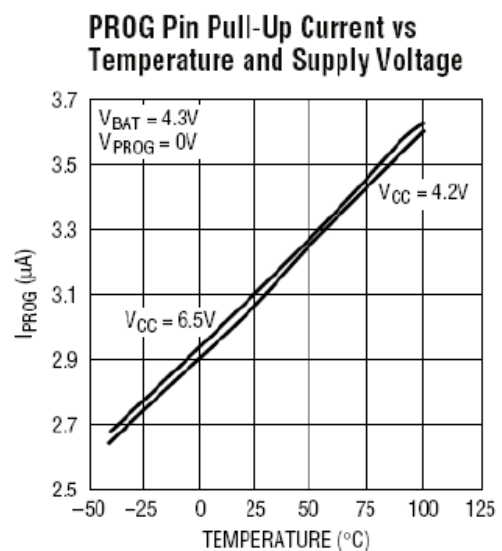
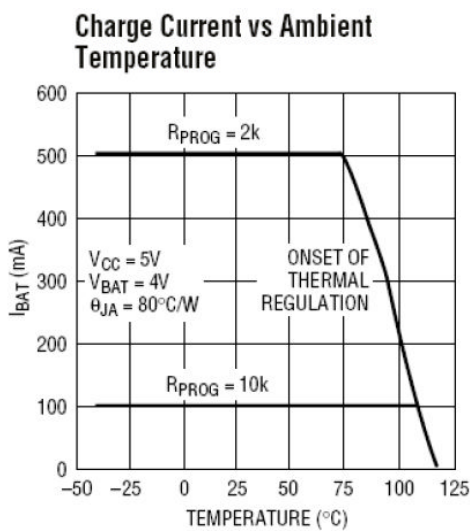
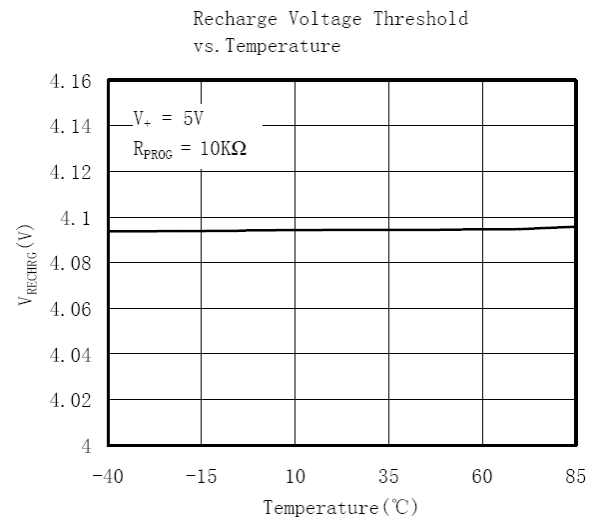
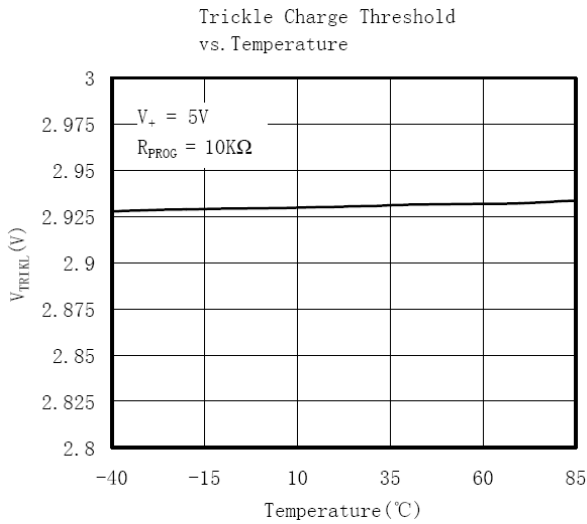
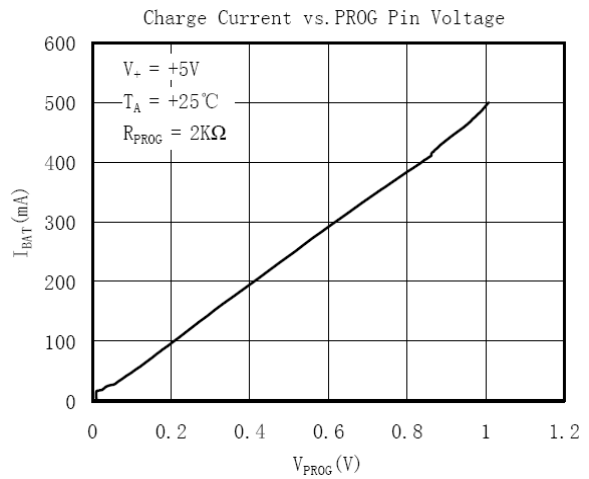
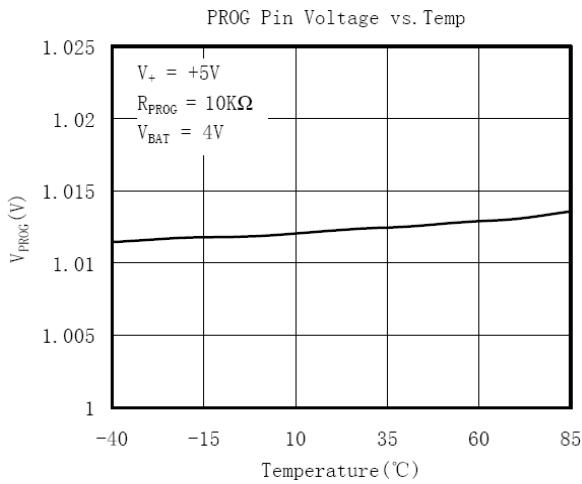


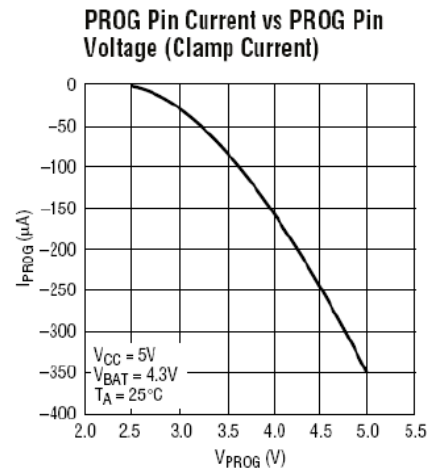
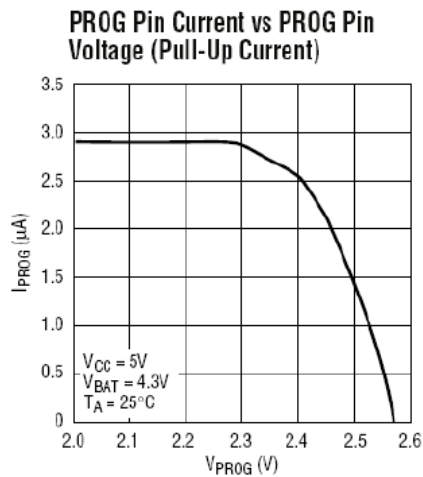
#### Basic Li-Ion Charger With Reverse Polarity Input Protection



## Typical Performance Characteristics



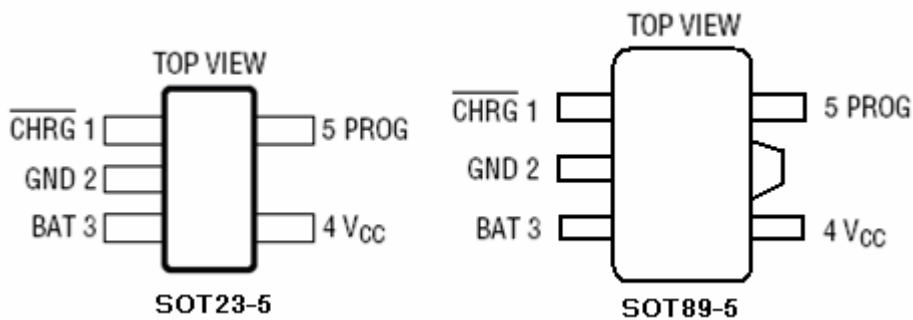




## Ordering Information

Part Number	Top Mark	Package
AP5054ES5	K1XY	SOT23-5L

## 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  $I_{BAT}$  to less than 2uA.

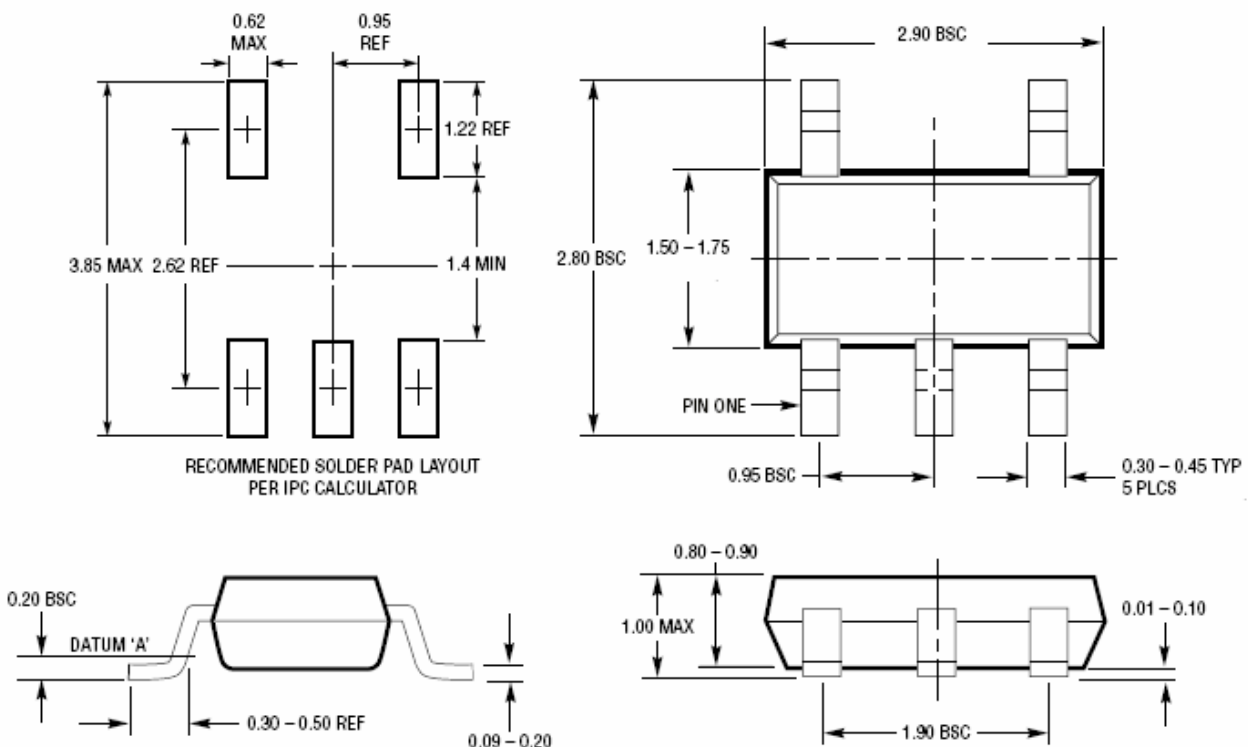
**PROG (Pin 5):** Charge Current Program, Charge Current Monitor and Shutdown Pin. The charge current is programmed by connecting a 1% resistor,  $R_{PROG}$ , to ground. When charging in constant-current mode, this pin serves to 1V. In all modes, the voltage on this pin can be used to measure the charge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

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

The  $P_{ROG}$  pin can also be used to shut down the charger. Disconnecting the program resistor from ground allows a 3uA current to pull the  $P_{ROG}$  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  $R_{PROG}$  to ground will return the charger to normal operation.

## Package Information

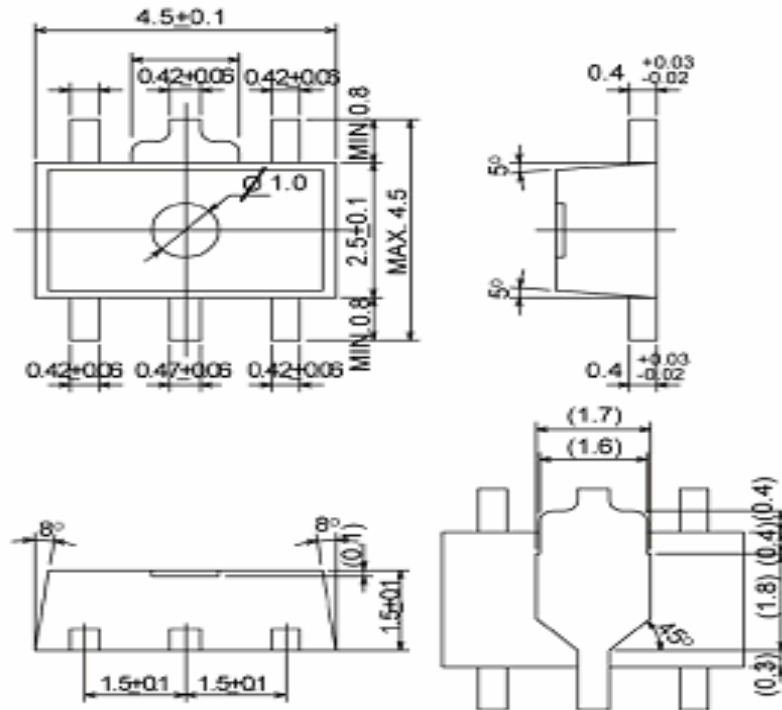
- SOT23-5L



# AP5054

• SOT89-5L

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