Standalone Linear Li-Lon Battery Charger with Thermal Regulation

Description

The HM4055S is a low cost, Single-cell, constant-current/constant-voltage Li-Ion battery charger. with a few external components the HM4055S is very small standalone charger for single lithium-ion batteries.

Charge current is set externally with a single resistor, no blocking diode is required due to the internal MOSFET architecture. The HM4055S charges to a final float voltage accurate to ±0.6%, The HM4055S automatically terminates the charge cycle when the charge current drops to 1/10th the programmed value after the final float voltage is reached and automatically puts into a sleep mode while removing input power.

The output is both current and thermally protected to prevent operating outside of safe limits. UVLO, Thermal, OVP and reverse connection protection are also available.

The HM4055S is available in SOT23-6 package.

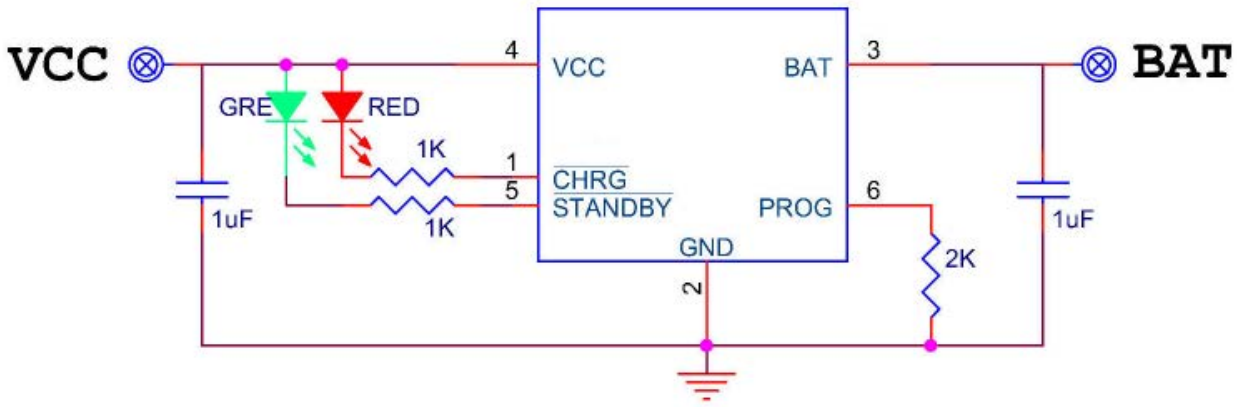
Features

- Standalone Li-Ion Charger with Thermal regulation
- Preset Charge Voltage with ±0.6% accuracy
- Suitable for USB-Powered Charging
- No Sense resistor or blocking diode required
- Programmable charge current: 100mA to 600mA.
- C/10 Charge termination
- 12V Absolute maximum Input voltage.
- Low battery charging conditioning
- 6.2V Input Over Voltage Protect
- Automatic Recharge
- Negligible Battery Drain Current in Shutdown
- Protection against battery reverse connection
- Self-protection for overcurrent/overtemperature
- Available in SOT23-6 Package

Applications

- Cellular telephones
- Handheld computers
- Charging docks and cradles
- Low cost and small size chargers

Typical Application

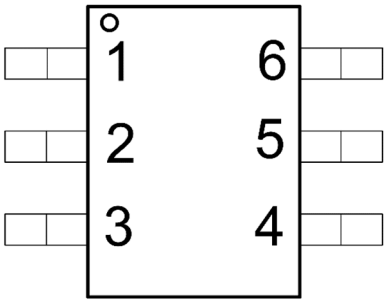


Absolute Maximum Ratings (at TA = 25°C)

Characteristics	Symbol	Rating	Unit
VCC to GND		-0.3 to 12	V
Prog, Std, Chrg to GND		-0.3 to +8.5	V
BAT to GND		-4.5~5.5	V
Power Dissipation	P_D	0.6	W
Operating Junction Temperature		-40 to 150	°C
Storage Junction Temperature		-55 to 150	°C
Thermal Resistance from Junction to case	θ_{JC}	130	°C/W
Thermal Resistance from Junction to ambient	θ_{JA}	170	°C/W

Pin Function And Descriptions

PIN	NAME	Description
1	$\overline{CHRG}$	Open-Drain Charging Status Output.
2	GND	Ground
3	BAT	Charge Current Output
4	VCC	Positive Input Supply Voltage
5	$\overline{STANDBY}$	Open-Drain Charge complete Status Output.
6	PROG	Charge Current Program, Charge Current Monitor and Shutdown Pin



Order information

Order Information	Top Marking
Preset Charge Voltage :4.15V	4055SE 15-XXX
Preset Charge Voltage :4.20V	4055SE 20-XXX
Preset Charge Voltage :4.25V	4055SE 25-XXX
Preset Charge Voltage :4.30V	4055SE 30-XXX
Preset Charge Voltage :4.35V	4055SE 35-XXX

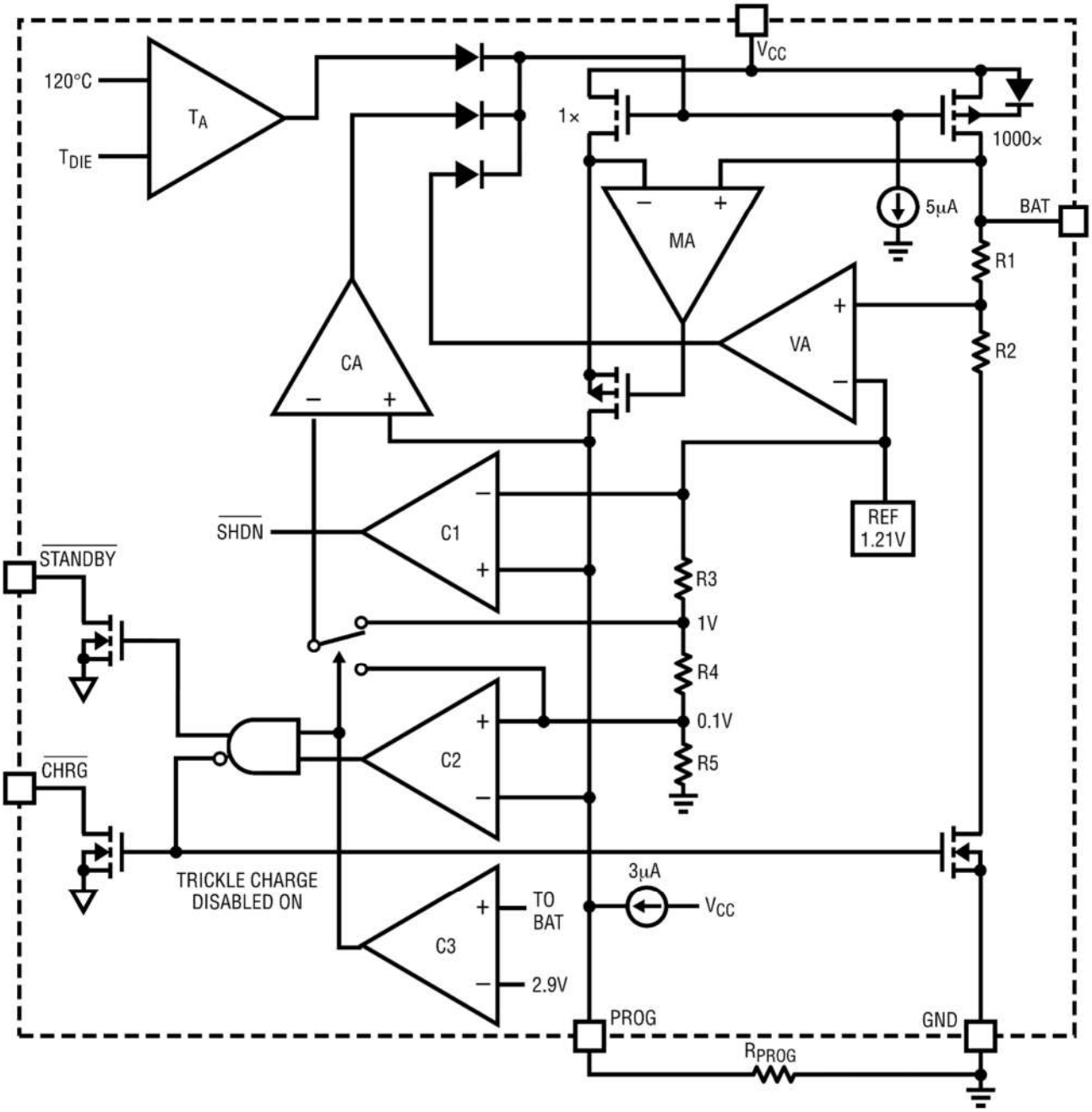
NOTE: XXX is the production date code

Electrical Characteristics

TJ = 25°C. VCC = 5.0V, unless otherwise noted

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Input Supply Voltage	VCC		4.7	-	6.2	V
Input Supply Current	ICC			150		uA
Regulated Output Voltage	V_{FLOAT}	Refer to the part NO.	-0.6		0.6	%
BAT Pin Current	I_{BAT}	R_{PROG}=2K	460	500	540	mA
		R_{PROG}=10K	90	100	110	mA
Trickle Charge Current	I_{TRICKL}	R_{PROG}=2K		50		mA
		R_{PROG}=10K		10		mA
Trickle Charge Threshold	V_{TRICKL}			2.9		V
C/10 Termination Current	I_{TERM}		8.5	10	11.5	%
PTOG Pin Voltage	V_{PROG}		0.93	1	1.07	V
Recharge Battery Threshold Voltage	V_{RECHRG}			150		mV
CHRG Pin Pull Down Current	I_{CHRG}			3		mA
STANDBY Pin Pull Down Current	$I_{STANDBY}$			3		mA
PROG Pin Pull up Current	IPROG			100		uA
Soft Start Time	Tss			100		uS
Junction Temperature in Constant Temperature Mode	T_{LIM}			120		°C
Recharge Filter Time	$T_{RECHARGE}$			2		mS
Power FET ON resistance				600		mΩ

Block Diagram



Operation

The HM4055S is a single cell lithium-ion battery charger using a constant-current constant-voltage algorithm. It can deliver up to 600mA of charge current (using a good thermal PCB layout) with a final float voltage accuracy of ±1%. The HM4055S includes an internal P-channel power MOSFET and thermal regulation circuitry. No blocking diode or external current sense resistor is required; thus, the basic charger circuit requires only two external components. Furthermore, the HM4055S is capable of operating from a USB power source.

Normal Charge Cycle

A charge cycle begins when the voltage at the VCC pin rises above the UVLO threshold level and a 1% program resistor is connected from the PROG pin to ground or when a battery is connected to the charger output. If the BAT pin is less than 2.9V, the charger enters trickle charge mode. In this mode, the HM4055S supplies approximately 1/10 the programmed charge current to bring the battery voltage up to a safe level for full current charging. When the BAT pin voltage rises above 2.9V, the charger enters constant-current mode, where the programmed charge current is supplied to the battery. When the BAT pin approaches the final float voltage (4.2V), the HM4055S enters constant-voltage mode and the charge current begins to decrease. When the charge current drops to 1/10 of the programmed value, the charge cycle ends

Programming Charge Current

The charge current is programmed using a single resistorfrom the PROG pin to ground. The battery charge current is 1000 times the current out of the PROG pin. The program resistor and the charge current are calculated using the following equations:

R_{PROG}= 1000V/I_{CHG}

The charge current out of the BAT pin can be determined at any time by monitoring the PROG pin voltage using the following equation:

IBAT=V_{PROG}/R_{PROG} •1000

Charge Termination

A charge cycle is terminated when the charge current falls to 1/10th the programmed value after the final float voltage is reached. This condition is detected by using an internal, filtered comparator to monitor the PROG pin. When the PROG pin voltage falls below 100mV for longer than 1ms, charging is terminated. The charge current is latched off and the HM4055S enters standby mode, where the input supply current drops to 200μA. When charging, transient loads on the BAT pin can cause the PROG pin to fall below 100mV for short periods of time before the DC charge current has dropped to 1/10th the programmed value. The 1ms filter time on the termination comparator ensures that transient loads of this nature do not result in premature charge cycle termination. Once the average charge current drops below 1/10th the programmed value, the HM4055S terminates the charge cycle and ceases to provide any current through the BAT pin. In this state, all loads on the BAT pin must be supplied by the battery. The HM4055S constantly monitors the BAT pin voltage in standby mode. If this voltage drops below the 4.05V recharge threshold (VRECHRG), another charge cycle begins and current is once again

supplied to the battery. To manually restart a charge cycle when in standby mode, the input voltage must be removed and reapplied, or the charger must be shut down and restarted using the PROG pin.

Charge Status Indicator

The CHRG and STANDBY charge status output has two different states: strong pull-down and high impedance. The CHRG strong pull-down state indicates that the HM4055S is in a charge cycle. Once the charge cycle has terminated, the CHRG pin state is change to High impedance and STANDBY pin change to strong pull-down state.

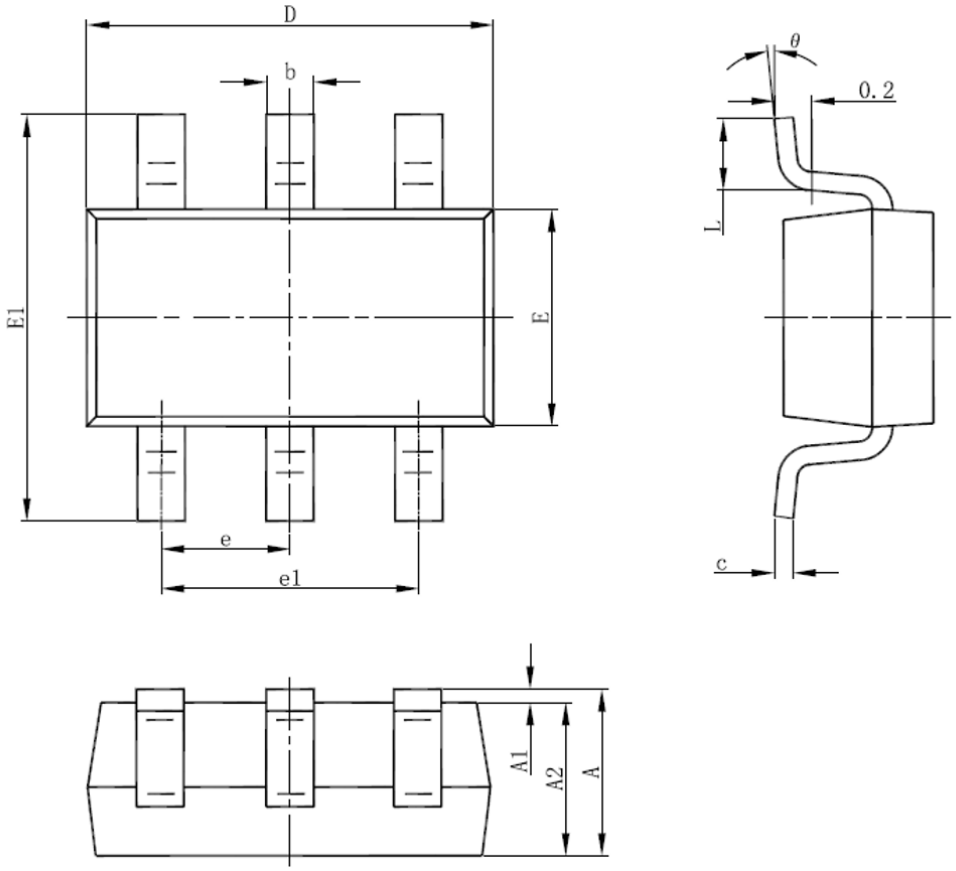
Thermal Regulation

An internal thermal feedback loop reduces the programmed charge current if the die temperature attempts to rise above a preset value of approximately 120°C. This feature protects the HM4055S from excessive temperature and allows the user to push the limits of the power handling capability of a given circuit board without risk of damaging the HM4055S. The charge current can be set according to typical (not worst-case) ambient temperature with the assurance that the charger will automatically reduce the current in worst-case conditions.

Because of the small size of the SOT package, it is very important to use a good thermal PC board layout to maximize the available charge current. The thermal path for the heat generated by the IC is from the die to the copper lead frame, through the package leads, (especially the ground lead) to the PC board copper. The PC board copper is the heat sink. The footprint copper pads should be as wide as possible and expand out to larger copper areas to spread and dissipate the heat to the surrounding ambient. Feedthrough vias to inner or backside copper layers are also useful in improving the overall thermal performance of the charger. Other heat sources on the board, not related to the charger, must also be considered when designing a PC board layout because they will affect overall temperature rise and the maximum charge current.

Package Description

SOT23-6 (unit：mm)



SYMBOL	MILLIMETER		
	MIN	NOR	MAX
A	-	-	1.35
A1	0.04	-	0.15
A2	1.00	1.10	1.20
b	0.3	0.4	0.5
c	0.1	0.15	0.2
D	2.72	2.92	3.12
E	1.40	1.60	1.80
E1	2.60	2.80	3.0
e	0.95BSC		
e1	1.90BSC		
L	0.30	-	0.60
θ	0	-	8°