TN4055

Linear Lithium-ion Battery Charger

Description

The TN4055 is a low cost, Single-cell, constant-current/constant-voltage Li-Ion battery charger. with a few external components, the TN4055 is very small stand alone 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 TN4055 charges to a final float voltage accurate to ±0.6%, The TN4055 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.

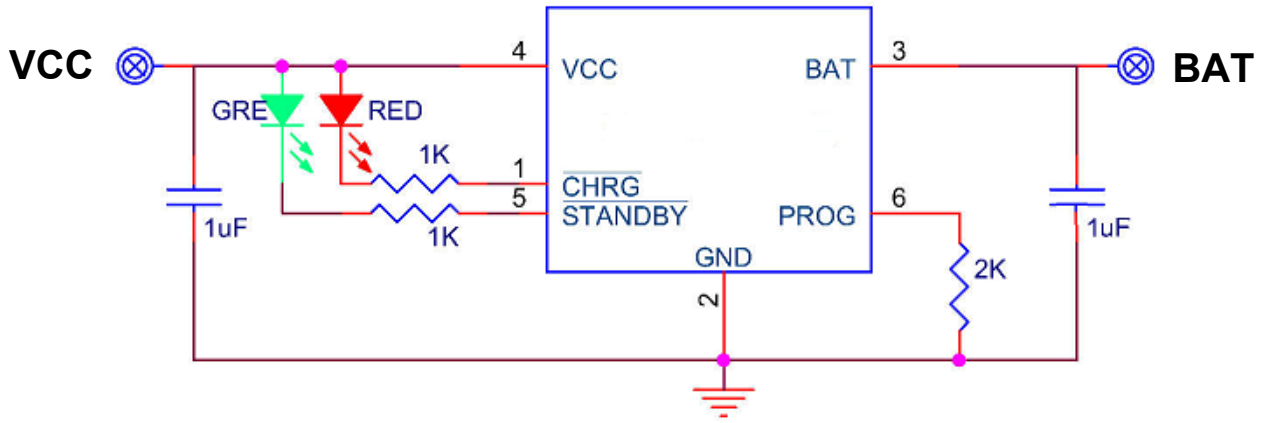
Features

- Standalone Li-Ion Charger with Thermal Regulation
- Programmable Charge Current Up to 600mA
- No Sense Resistor or Blocking Diode Required Preset Charge
- Voltage with ±0.6% Accuracy
- Suitable for USB-Powered Charging
- 6.2V Input Over Voltage Protect
- C/10 ChargeTermination
- 12V Absolute Maximum Input Voltage
- Low Battery Charging Conditioning
- Automatic Recharge
- Negligible Battery Drain Current in Shutdown
- Protection Against Battery Reverse Connection
- Self-protection for Overcurrent/Overtemperature
- Available in SOT-23-6 Package

Application

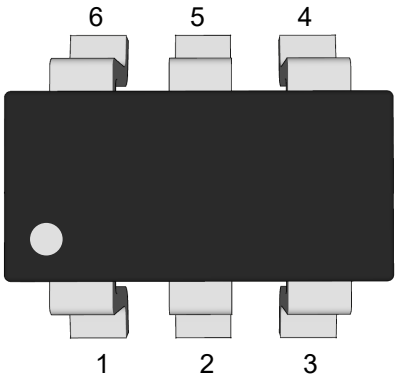
- Cellular Telephones
- Charging Docks and Cradles
- Handheld Computers
- Low Cost and Small Size Chargers

Typical Applications



Pin Distribution

SOT-23-6



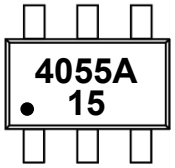
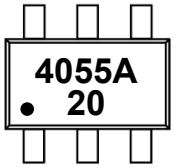
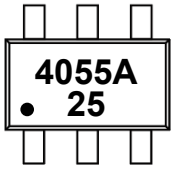
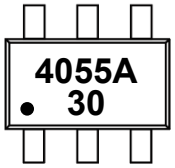
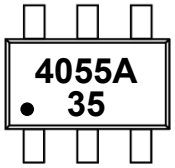
Pin Function

Pin No.	Symbol	Pin Function
1	CHRG	Open-Drain Charge Status Output.
2	GND	Ground Pin.
3	BAT	Charging Current Output.
4	VCC	Positive Input Vower Voltage.
5	STANDBY	The Charging Status Indicates That When The Battery is Charged
6	PROG	Charge Current Program, Charge Current Monitor and Shutdown Pin.

Ordering Information

TN4055□□□□

- Package Type
  SG : SOT-23-6
- Float Voltage
  15 : 4.15V 20 : 4.20V 25 : 4.25V
  30 : 4.30V 35 : 4.35V
- Revision : A

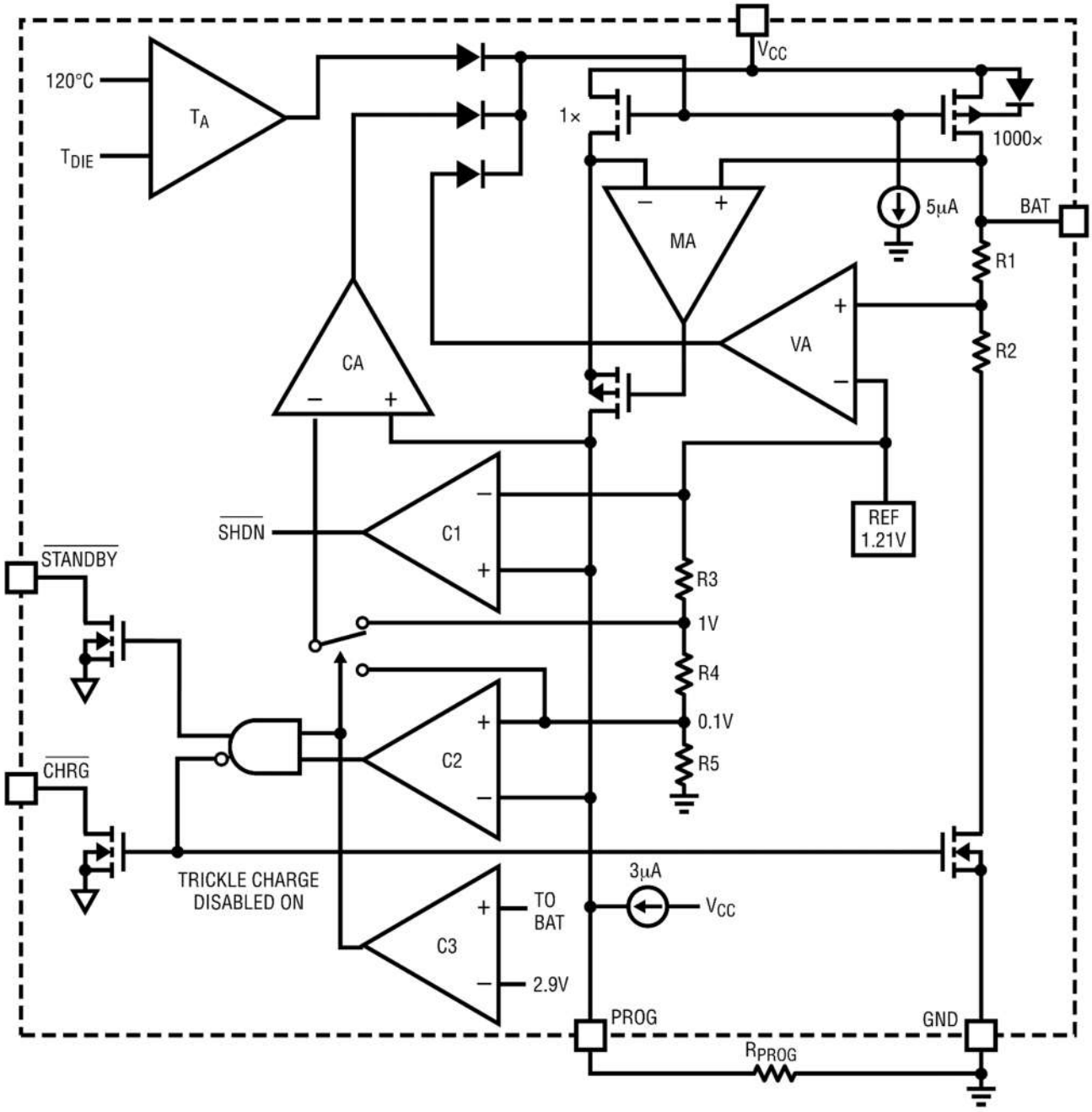
Orderable Device	Package	Reel (inch)	Package Qty (PCS)	Eco Plan Note	MSL Level	Marking Code
TN4055A15SG	SOT-23-6	7	3000	RoHS & Green	MSL3	
TN4055A20SG	SOT-23-6	7	3000	RoHS & Green	MSL3	
TN4055A25SG	SOT-23-6	7	3000	RoHS & Green	MSL3	
TN4055A30SG	SOT-23-6	7	3000	RoHS & Green	MSL3	
TN4055A35SG	SOT-23-6	7	3000	RoHS & Green	MSL3	

Note:

RoHS: TN defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials.

Green: TN defines "Green" to mean Halogen-Free and Antimony-Free.

Block Diagram



Absolute Maximum Ratings

Ratings at 25℃ ambient temperature unless otherwise specified.

Parameter	Symbol	Ratings	Unit
VCC Input Voltage	V_{CC}	-0.3~12	V
Prog Pin Voltage	V_{PROG}	-0.3~8.5	V
CHG,BAT Pin Voltage	V_{BAT}	-4.5~5.5	V
Power Dissipation	P_D	0.6	W
Operating Junction Temperature Range	T_J	-40~+150	°C
Storage Temperature	T_{STG}	-55~+150	°C

Thermal Information

Parameter	Symbol	Ratings	Unit
Junction-to-Ambient Thermal Resistance	$R_{\theta JA}$	170	°C/W
Junction-to-Case (top) Thermal Resistance	$R_{\theta JC}$	130	°C/W

Electrical Characteristics

(V_{IN}=5V, T_J=25℃ , unless otherwise noted.)

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Input Supply Voltage	V_{CC}		4.5	--	6.2	V
Input Supply Current	I_{CC}		--	150	--	μA
Regulated Output (Float) Voltage	V_{FLOAT}		-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_{TRIKL}	R_{PROG} = 2k	--	50	--	mA
		R_{PROG} = 10k	--	10	--	
Trickle Charge Threshold	V_{TRIKL}		--	2.9	--	V
C/10 Termination Current	I_{TERM}		8.5	10	11.5	%
PROG Pin Voltage	V_{PROG}		0.93	1.0	1.07	V
Recharge Battery Threshold	$\triangle V_{RECHG}$		--	100	--	mV
CHRG Pin Weak Pull Down Current	I_{CHRG}		--	3	--	mA
PROG Pin Pull-Up Current	I_{PROG}		--	3	--	μA
RechargeComparat or Filter time	$t_{RECHARGE}$		--	2	--	mS
Soft-Start time	t_{SS}		--	700	--	μS
Junction Temperature in Constant Temperature Mode	T_{LIM}		--	120	--	°C
Power FET On resistance			--	600	--	mΩ

Operation

The TN4055 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 TN4055 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 TN4055 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 TN4055 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 PJ4055 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 resistor from 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:

$$R_{PROG}=\frac{1000V}{I_{CHG}} \qquad I_{PROG}=\frac{1000V}{R_{PROG}}$$

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

$$I_{BAT}=\frac{V_{PROG}}{R_{PROG}}\times 1000$$

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 TN4055 enters standby mode, where the input supply current drops to 170μA. 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 TN4055 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 TN4055 constantly monitors the BAT pin voltage in standby mode. If this voltage drops below the 4.1V 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 TN4055 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.

Charging Status	CHRG
Charging	Bright
Charge Complete	Snuffed Out
NO Battery	Flashing
Undervotagle	Snuffed Out
Reverse Battery Connection	Snuffed Out

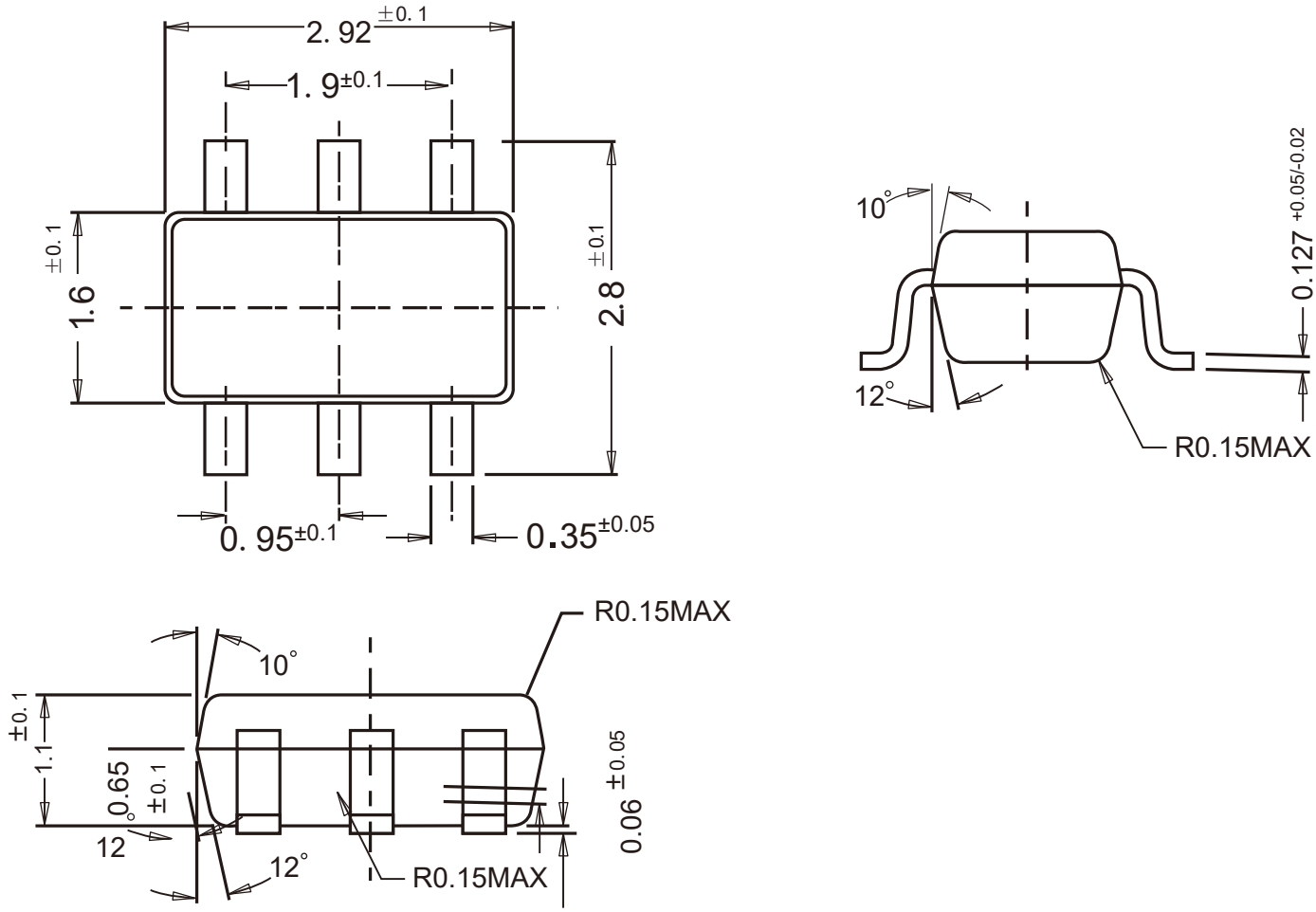
Thermal Limiting

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 TN4055 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 TN4055. 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 Outline SOT-23-6

Dimensions in mm



Contact Information

TANI website: **http://www.tanisemi.com** Email:tani@tanisemi.com

For additional information, please contact your local Sales Representative.

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