TN4056B

Linear Lithium-ion Battery Charger IC

Description

The TN4056B is a low cost, Single-cell, constant-current/constant-voltage Li-Ion battery charger. with a few external components the TN4056B 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 TN4056B charges to a final float voltage accurate to ±0.6%, The TN4056B 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.

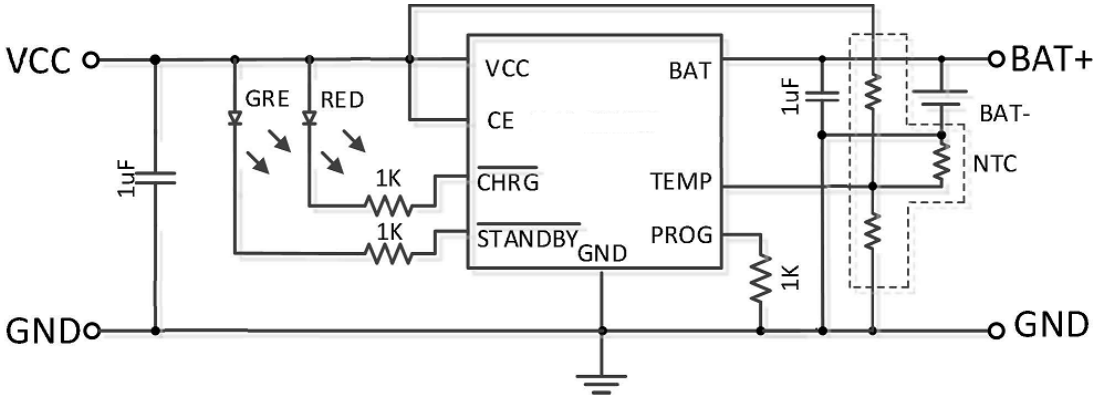
Features

- Standalone Li-Ion Charger with Thermal regulation
- Preset Charge Voltage with ±0.6% accuracy
- Suitable for USB-Powered Charging
- No Sense resistor or blocking diode required
- Programmable charge current: 100mA to 1000mA
- 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 ESOP-8 Package

Applications

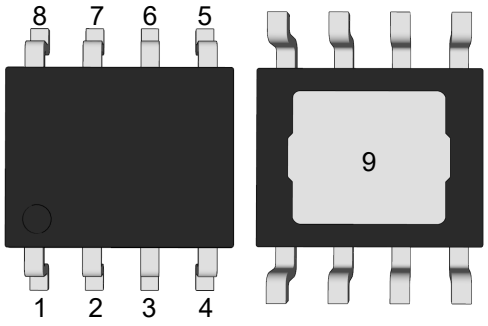
- Cellular telephones
- Handheld computers
- Charging docks and cradles
- Low cost and small size chargers

Typical Application



Pin Distribution

ESOP-8



(Top View) (Bottom View)

Pin Function

Pin No.	Symbol	Pin Function
1	TEMP	Battery Temperature Detection Pin
2	PROG	Charge Current Program, Charge Current Monitor and Shutdown Pin
3	GND	Ground
4	VCC	Positive Input Supply Voltage
5	BAT	Charge Current Output
6	$\overline{\text{STANDBY}}$	Open-Drain Charge Complete Status Output
7	$\overline{\text{CHRG}}$	Open-Drain Charging Status Output.
8	CE	Enable Pin
9	Thermal Pad	The Thermal Pad Must be Connected to GND and Welded to a Large Area of PCB Copper for Maximum Heat Dissipation.

Ordering Information

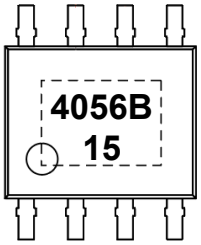
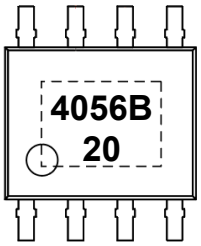
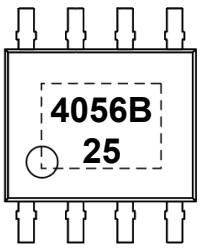
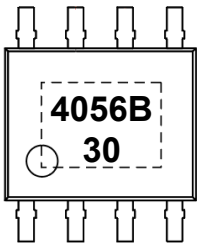
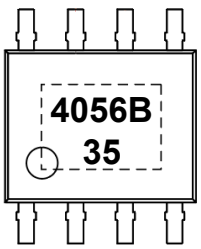
TN4056□□□□

Package Type
PB : ESOP-8

Float Voltage
15 : 4.15V 20 : 4.20V 25 : 4.25V
30 : 4.30V 35 : 4.35V

Revision : B

Order information Continue

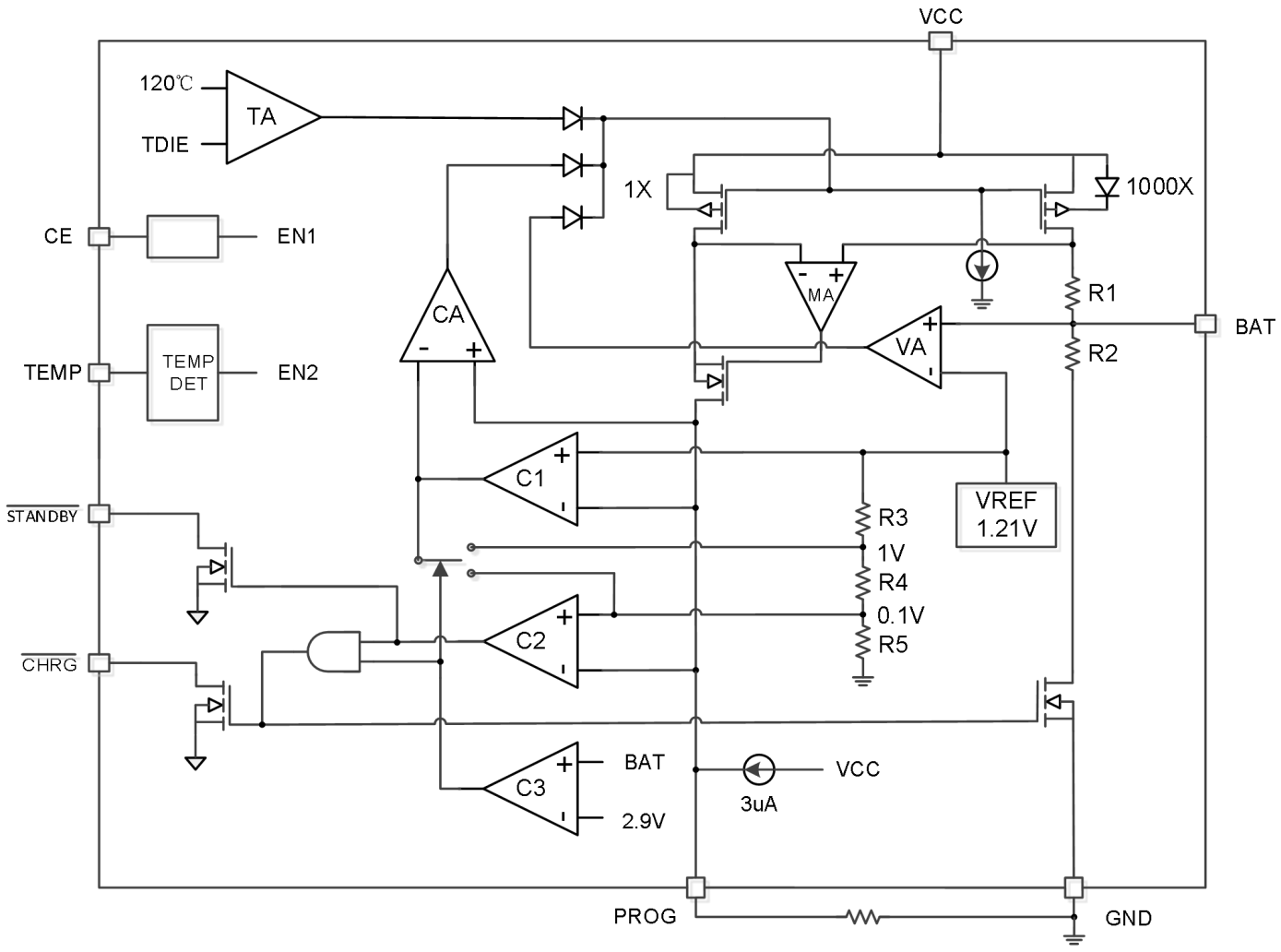
Orderable Device	Device	Reel(inch)	Package Qty. (PCS)	Eco Plan Note	MSL Level	Marking Code
TN4056B15PB	ESOP-8	13	4000	RoHS & Green	MSL3	
TN4056B20PB	ESOP-8	13	4000	RoHS & Green	MSL3	
TN4056B25PB	ESOP-8	13	4000	RoHS & Green	MSL3	
TN4056B30PB	ESOP-8	13	4000	RoHS & Green	MSL3	
TN4056B35PB	ESOP-8	13	4000	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

(T_A=25°C ,unless otherwise noted.)

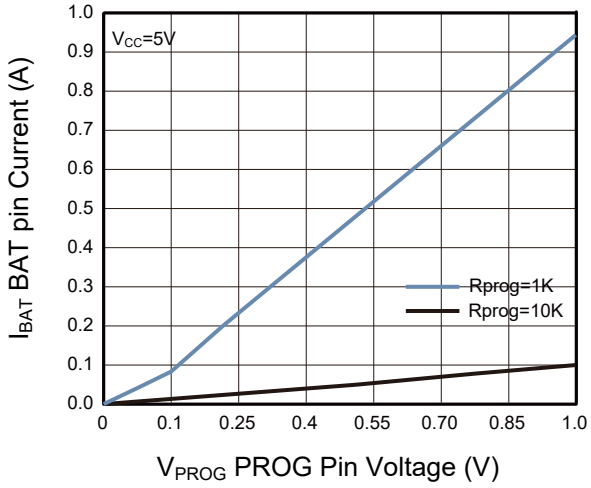
Parameter	Symbol	Ratings	Unit
VCC to GND Voltage	V_{CC}	-0.3~12	V
Prog ,Std, Chrg to GND Voltage	--	-0.3~8.5	V
BAT Pin to Voltage	V_{BAT}	-4.5~5.5	V
Power Dissipation	P_D	1.5	W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	67	°C/W
Operating Junction Temperature Range	T_{OPR}	-40~+85	°C
Storage Temperature	T_{STG}	-55~+125	°C

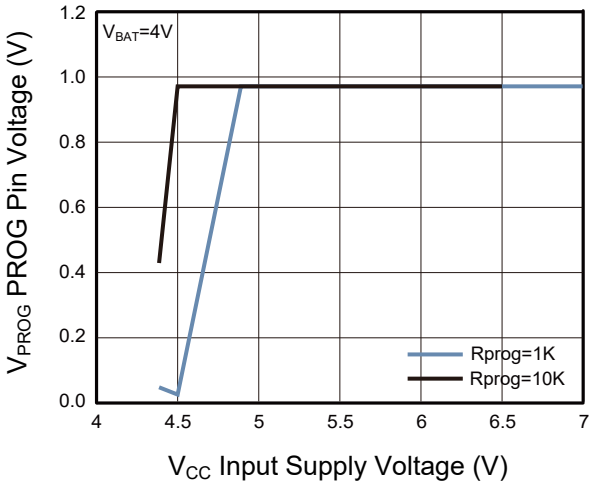
Electrical Characteristics

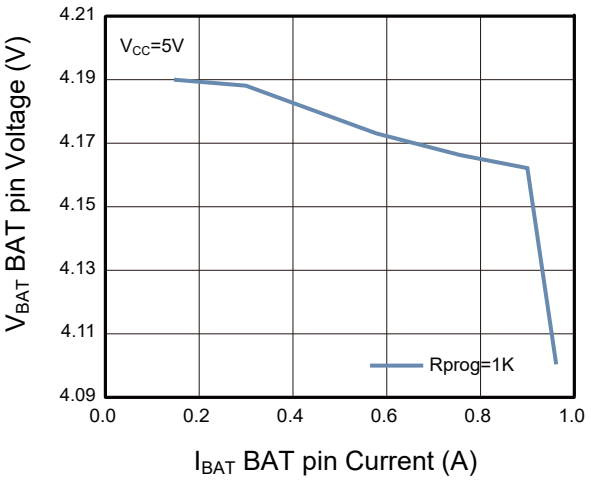
(T_J=25°C,V_{CC}=5V, unless otherwise noted.)

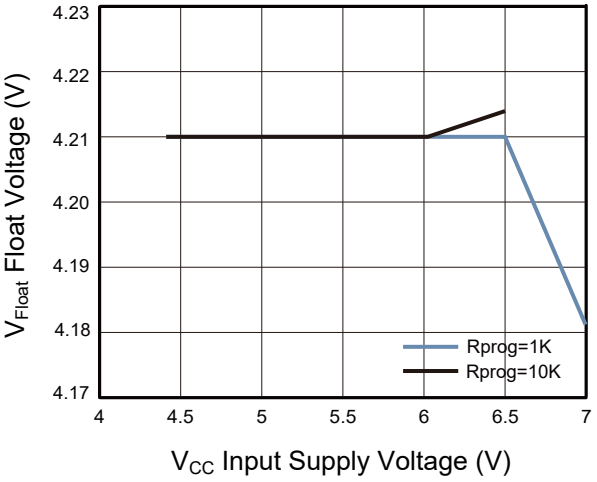
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Input Supply Voltage	V_{CC}		4.7	--	6.2	V
Input Supply Current	I_{CC}		--	150	--	μA
Regulated Output (Float) Voltage	V_{FLOAT}		-0.6	--	0.6	%
BAT Pin Current	I_{BAT}	R_{PROG} = 1k	900	1000	1100	mA
		R_{PROG} = 10k	90	100	110	mA
Trickle Charge Current	I_{TRIKL}	R_{PROG} = 1k	--	100	--	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	$\triangle V_{RECHG}$		--	180	--	mV
CHRG Pin Weak Pull Down Current	I_{CHRG}		--	3	--	mA
STANDBY Pin Pull Down Current	$I_{STANDBY}$		--	3	--	mA
TEMP Pin High-side flip Voltage	V_{TEMP_H}		--	80	83	%V_{CC}
TEMP Pin Low-side flip Voltage	V_{TEMP_L}		42	45	--	%V_{CC}
PROG Pin Pull-Up Current	I_{PROG}		--	100	--	μA
RechargeComparat or Filter time	$t_{RECHARGE}$		--	2	--	mS
Soft-Start time	t_{SS}		--	100	--	μS
Junction Temperature in Constant Temperature Mode	T_{LIM}		--	120	--	°C
Power FET On resistance	--		--	600	--	mΩ

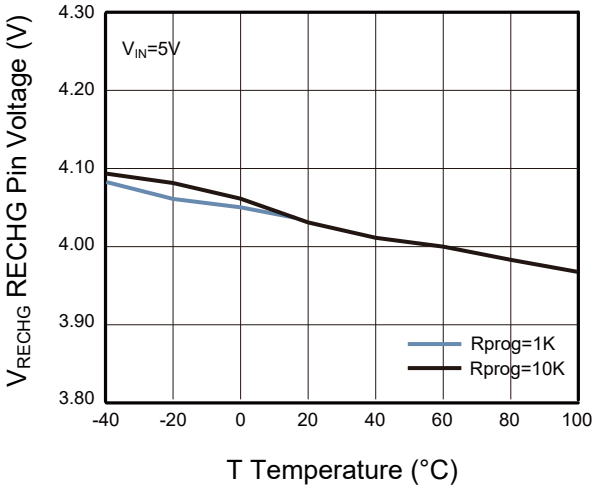
Typical Characteristics Curves

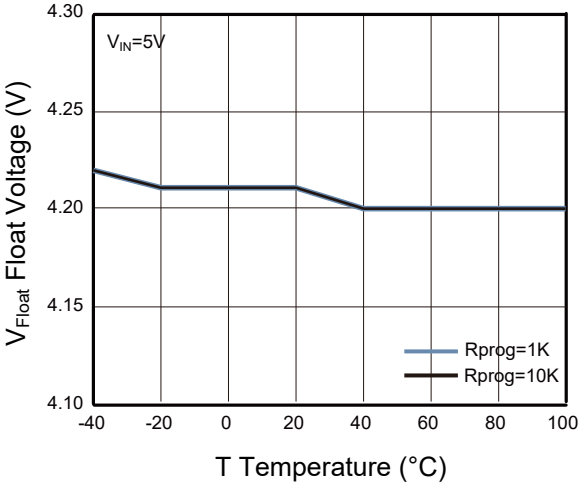


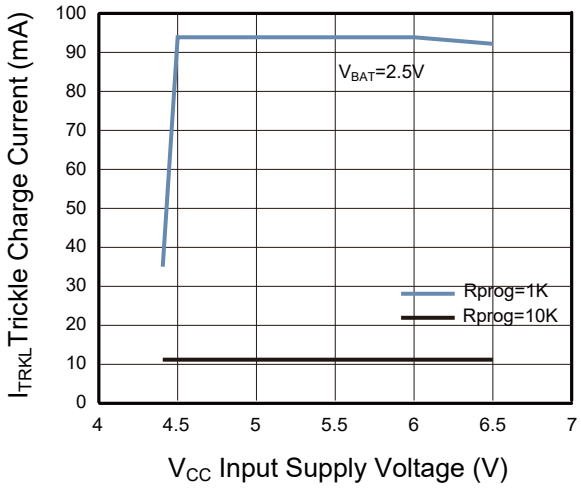


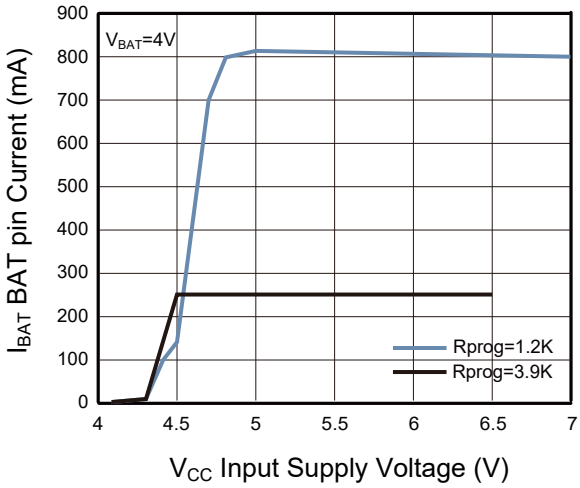


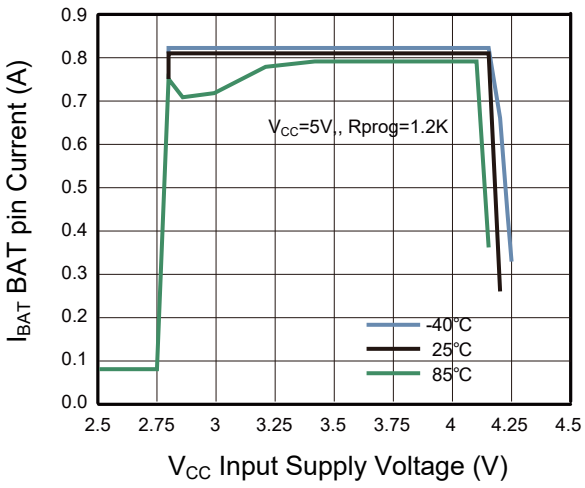


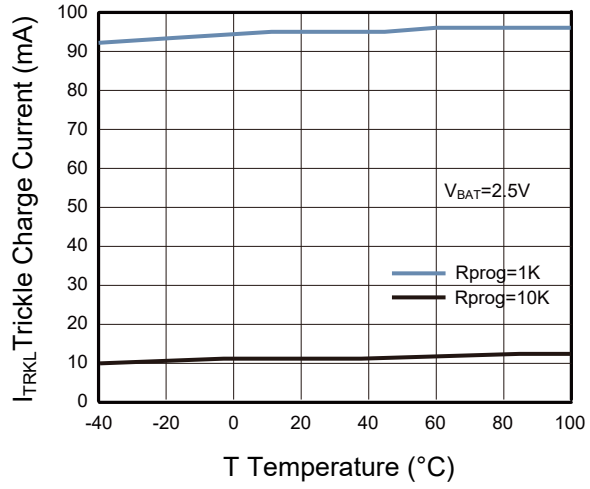


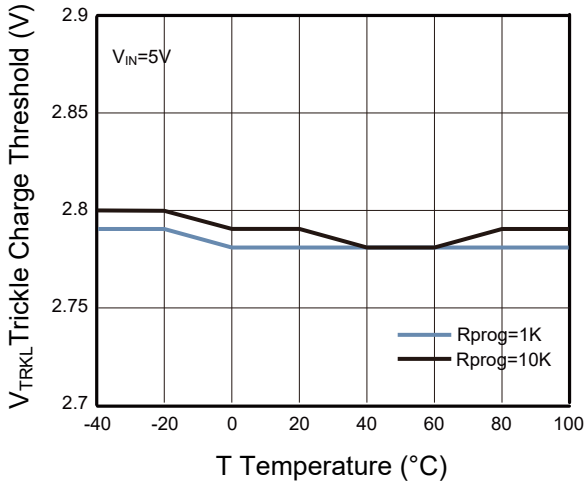


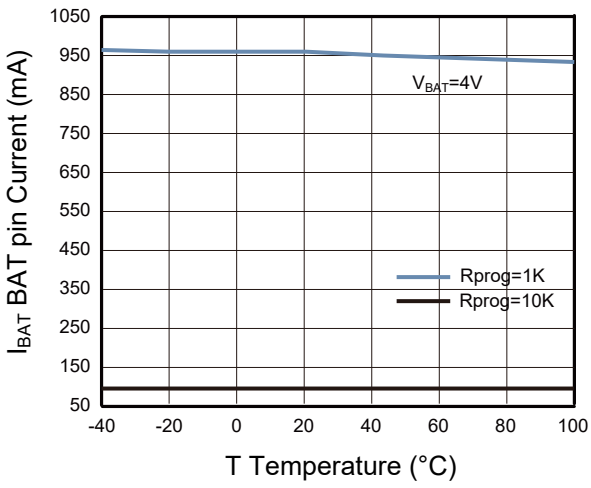












Operation

The TN4056B is a single cell lithium-ion battery charger using a constant-current constant-voltage algorithm. It can deliver up to 1000mA of charge current (using a good thermal PCB layout) with a final float voltage accuracy of ±1%. The TN4056B includes an internal P-channel power MOSFET and thermal regulation circuitry. The TN4056B has two open-drain status indicator outputs. CHRG is a charge status indicator and STDBY is a battery charge completion indicator.Furthermore, the TN4056B 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 TN4056B 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 TN4056B 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:

$$RPROG= 1000V/ICHG$$

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

$$IBAT=VPROG/RPROG \bullet 1000$$

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 TN4056B enters standby mode, where the input supply current drops to 150μA. 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 TN4056B 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 TN4056B constantly monitors the BAT pin voltage in standby mode. If this voltage drops below the 4.03V 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 TN4056B 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 TN4056B 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 TN4056B. 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.

Battery Temperature Detection

To prevent damage to the battery caused by too high or too low temperatures, the TN4056B has integrated battery temperature monitoring circuitry. Battery temperature monitoring is achieved by measuring the voltage on the TEMP pin, which is achieved by an NTC thermistor within the battery and a resistor divider network, as shown in a typical application illustration. If the voltage on the TEMP pin is less than 45% of the input voltage or greater than 80% of the input voltage, it means that the battery temperature is too low or too high, and charging is suspended. If the TEMP pin is directly connected to GND, then the battery temperature detection function is canceled and the other charging functions are normal.

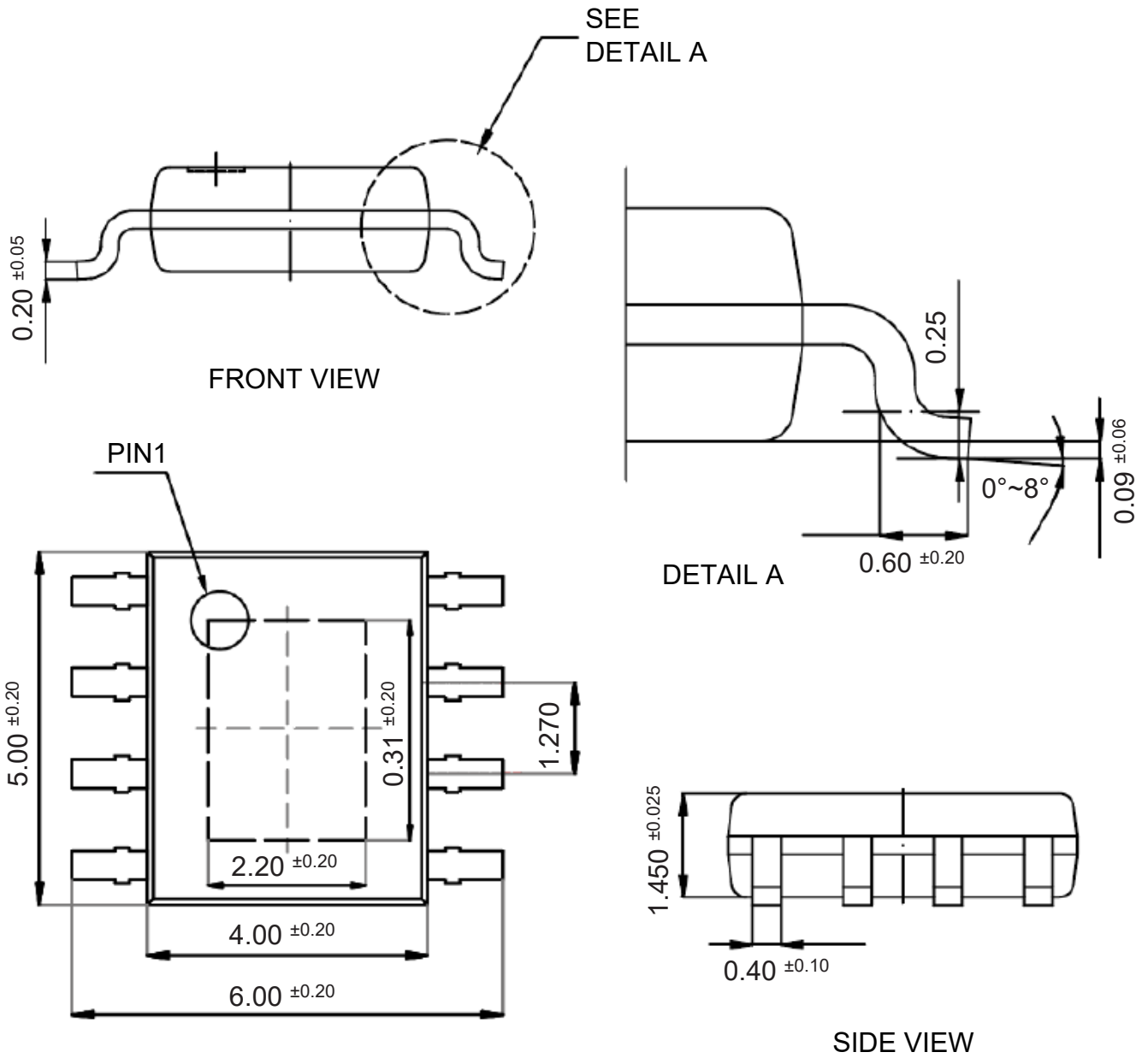
Layout Consideration

Because of the small size of the ESOP-8 package, it is very important to use a good thermal PCB 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 PCB copper. The PCB 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 PCB layout because they will affect overall temperature rise and the maximum charge current.

Package Outline

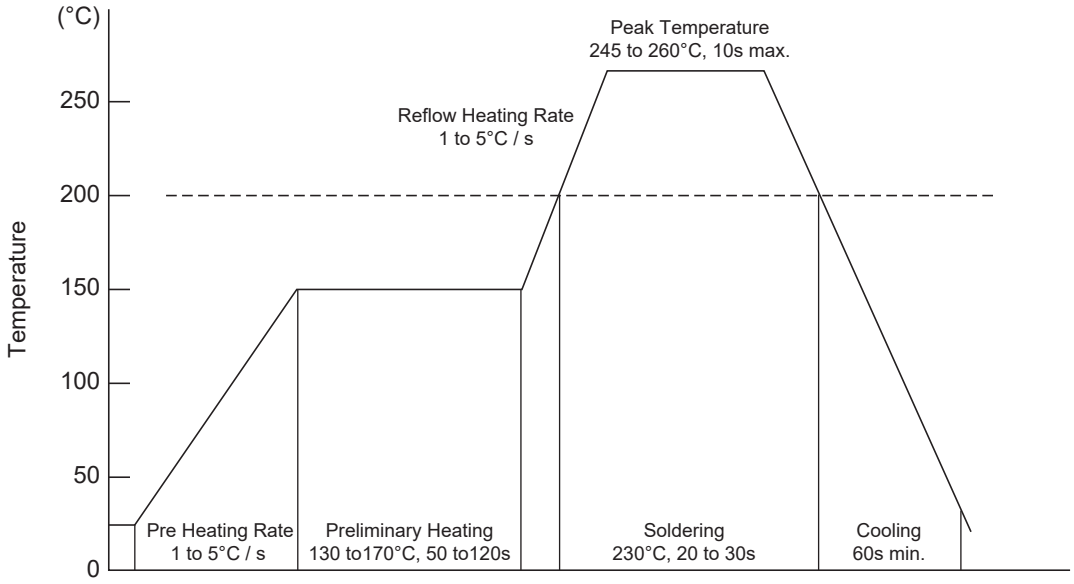
ESOP-8

Dimensions in mm



Conditions of Soldering and Storage

◆ Recommended condition of reflow soldering



Recommended peak temperature is over 245°C. If peak temperature is below 245°C, you may adjust the following parameters:

- Time length of peak temperature (longer)
- Time length of soldering (longer)
- Thickness of solder paste (thicker)

◆ Conditions of hand soldering

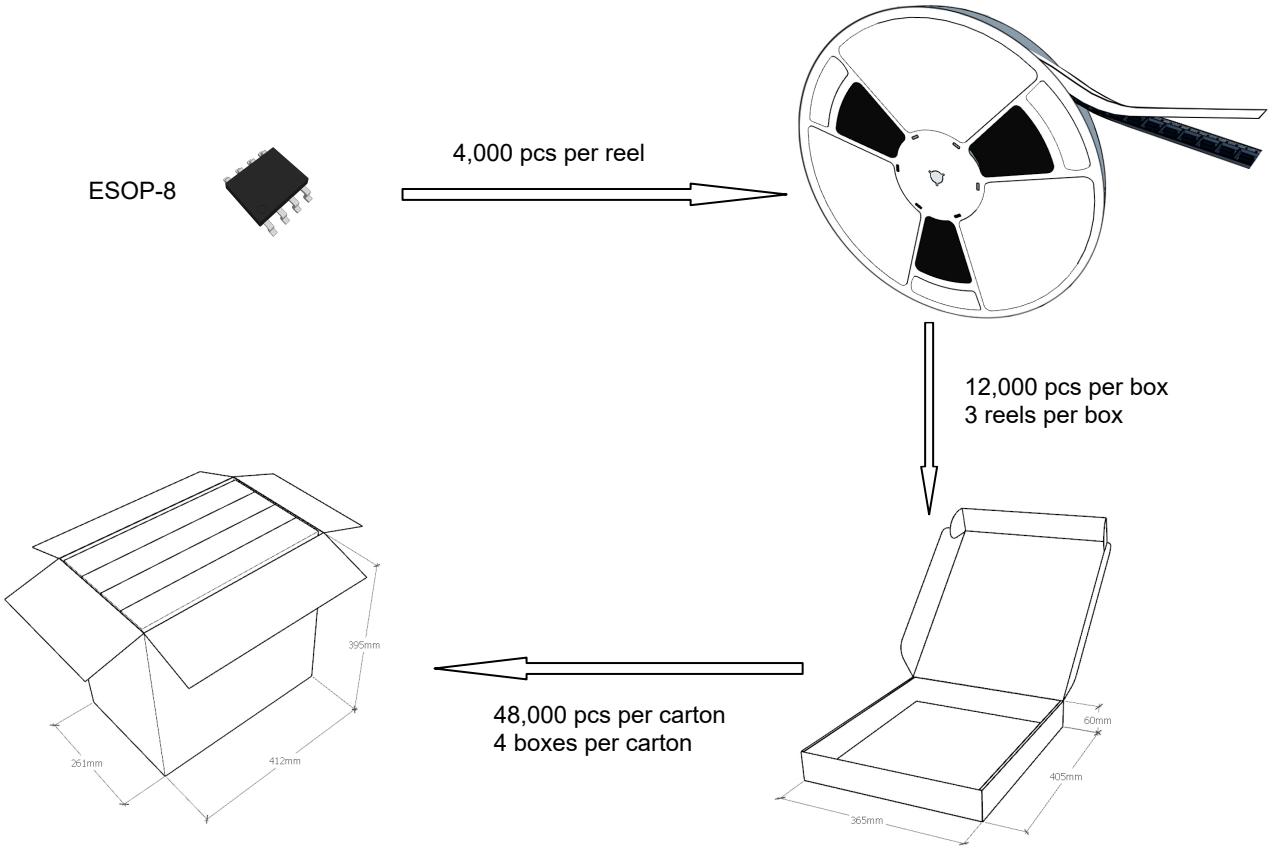
- Temperature: 300°C
- Time: 3s max.
- Times: one time

◆ Storage conditions

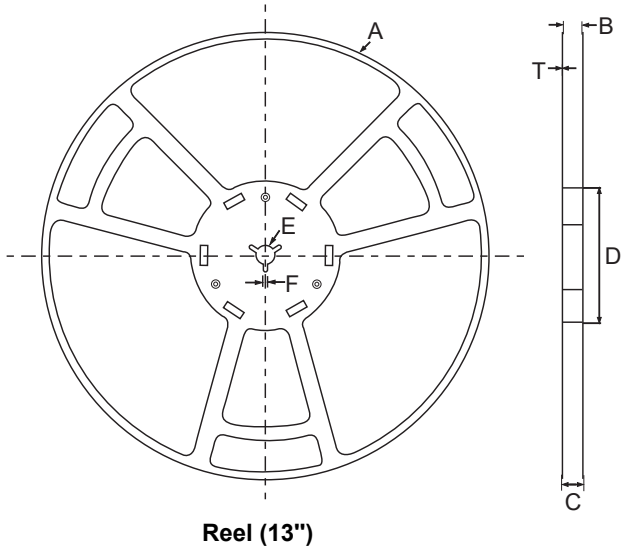
- **Temperature**
  5 to 40°C
- **Humidity**
  30 to 80% RH
- **Recommended period**
  One year after manufacturing

Package Specifications

- The method of packaging

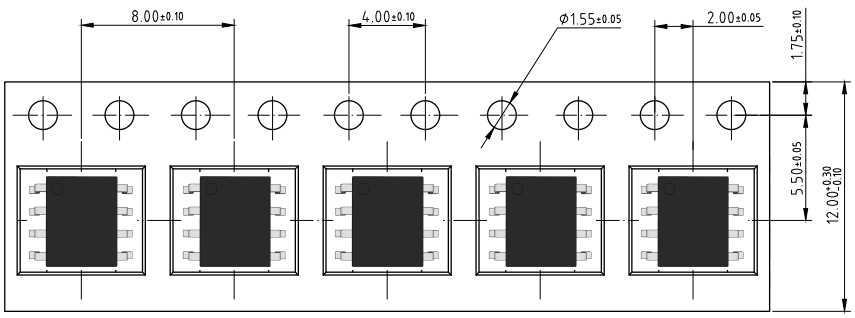


◆ Embossed tape and reel data



Reel (13")

symbol	Value(unit:mm)
A	ϕ330±1
B	12.7±0.5
C	16.5±0.3
D	ϕ99.5±0.5
E	ϕ13.6±0.3
F	2.8±0.3
T	1.9±0.2



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

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Product Specification Statement

The product specification aims to provide users with a reference regarding various product parameters, performance, and usage. It presents certain aspects of the product's performance in graphical form and is intended solely for users to select product and make product comparisons, enabling users to better understand and evaluate the characteristics and advantages of the product. It does not constitute any commitment, warranty, or guarantee.

The product parameters described in the product specification are numerical values, characteristics, and functions obtained through actual testing or theoretical calculations of the product in an independent or ideal state. Due to the complexity of product applications and variations in test conditions and equipment, there may be slight fluctuations in parameter test values. TANI shall not guarantee that the actual performance of the product when installed in the customer's system or equipment will be entirely consistent with the product specification, especially concerning dynamic parameters. It is recommended that users consult with professionals for product selection and system design. Users should also thoroughly validate and assess whether the actual parameters and performance when installed in their respective systems or equipment meet their requirements or expectations. Additionally, users should exercise caution in verifying product compatibility issues, and TANI assumes no responsibility for the application of the product. TANI strives to provide accurate and up -to- date information to the best of our ability. However, due to technical, human, or other reasons, TANI cannot guarantee that the information provided in the product specification is entirely accurate and error-free. TANI shall not be held responsible for any losses or damages resulting from the use or reliance on any information in these product specifications.

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Users are advised to pay attention to the parameter limit values specified in the product specification and maintain a certain margin in design or application to ensure that the product does not exceed the parameter limit values defined in the product specification. This precaution should be taken to avoid exceeding one or more of the limit values, which may result in permanent irreversible damage to the product, ultimately affecting the quality and reliability of the system or equipment.

The design of the product is intended to meet civilian needs and is not guaranteed for use in harsh environments or precision equipment. It is not recommended for use in systems or equipment such as medical devices, aircraft, nuclear power, and similar systems, where failures in these systems or equipment could reasonably be expected to result in personal injury. TANI shall assume no responsibility for any consequences resulting from such usage.

Users should also comply with relevant laws, regulations, policies, and standards when using the product specification. Users are responsible for the risks and liabilities arising from the use of the product specification and must ensure that it is not used for illegal purposes. Additionally, users should respect the intellectual property rights related to the product specification and refrain from infringing upon any third- party legal rights. TANI shall assume no responsibility for any disputes or controv ersies arising from the above-mentioned issues in any form.