



## 1A Single Chip Li-Ion and Li-Polymer Charger

### General Description

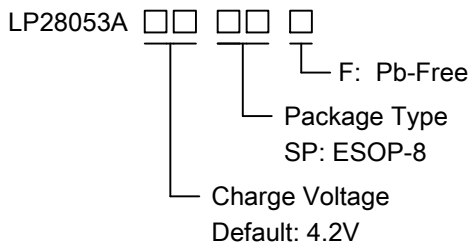
The LP28053A is a complete constant-current/constant voltage linear charger for single cell lithium-ion battery. Its ESOP8 package and low external component count make the LP28053A ideally suited for portable applications. No external sense resistor is needed, and no blocking diode is required due to 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 ISET programmed externally with a single resistor.

The LP28053A automatically terminates the charge cycle when the charge current drops to 1/10 setting current value after the final float voltage is reached.

When the input supply is removed, the LP28053A automatically enters a low current state, dropping the battery drain current to less than  $< 1\mu\text{A}$ .

Other features include charge current monitor, under voltage lockout, automatic recharge and a status pin.

### Order Information



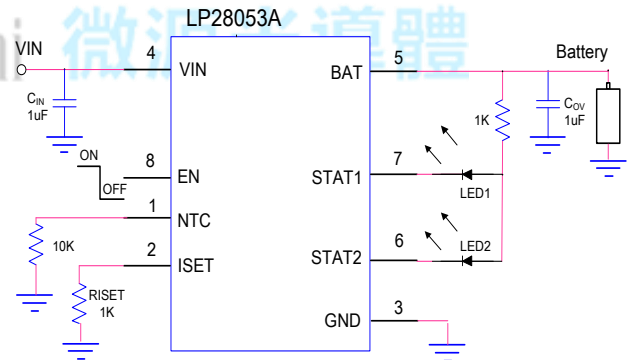
### Applications

- ✧ Portable Media Players/Game
- ✧ Power Bank
- ✧ Bluetooth Applications
- ✧ PDA/MID

### Features

- ◆ Input Voltage up to 28V
- ◆ Input Over Voltage Protection : 7V
- ◆ Short-circuit protection
- ◆ Programmable Charge Current Up to 1000mA
- ◆  $< 1\mu\text{A}$  Battery Reverse Current
- ◆ Protection of Reverse Connection of Battery
- ◆ No MOSFET, Sense Resistor or Blocking Diode Required
- ◆ Constant-Current/Constant-Voltage Operation with Thermal Regulation to Maximize Charge Rate Without Risk of Overheating
- ◆ ESOP-8 Package
- ◆ RoHS Compliant and 100% Lead (Pb)-Free

### Typical Application Circuit



### Marking Information

Device	Marking	Package	Shipping
LP28053ASPF	LPS LP28053A YWX	ESOP-8	4K/REEL
Marking indication: Y:Production year W:Production week X: Series Number			



## Functional Pin Description

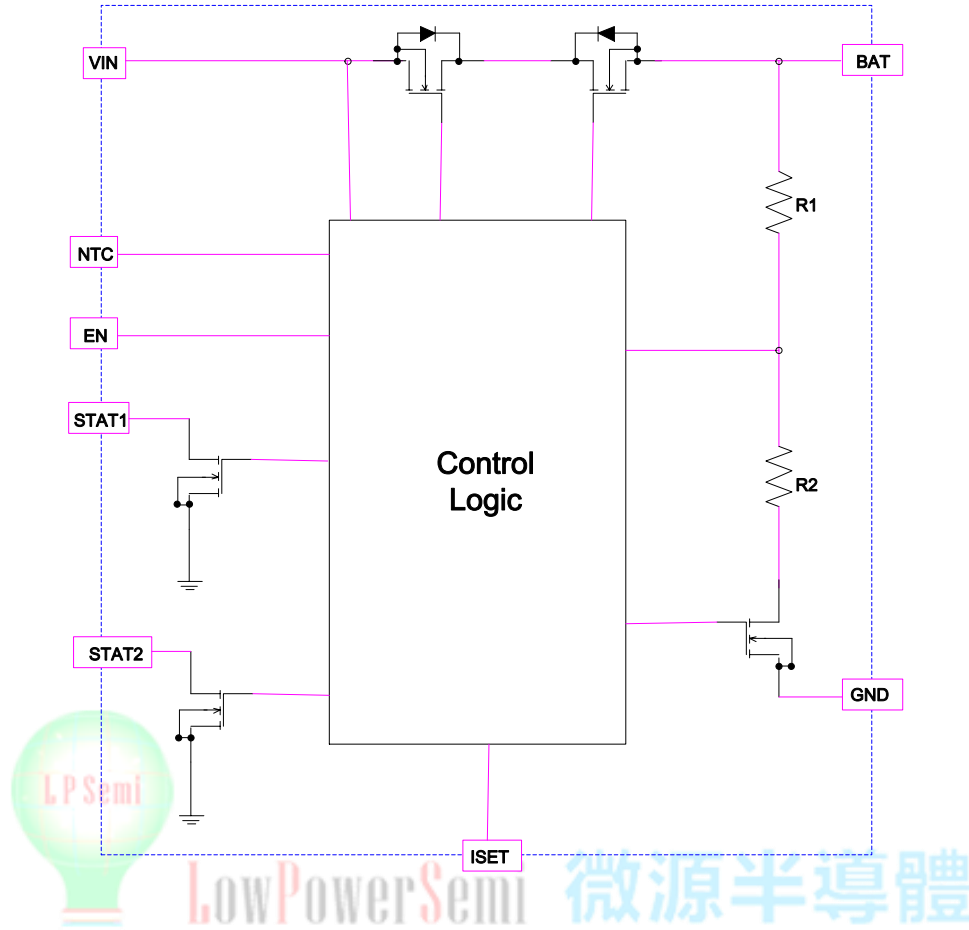
Package Type	Pin Configurations
ESOP-8	<p style="text-align: center;">ESOP-8 TOP VIEW</p>

## Pin Description

No.	NAME	DESCRIPTION
1	NTC	Negative Thermal Coefficient (NTC) Thermistor Pin.
2	ISET	Charge Current Program. The charge current is programmed by connecting a 1% resistor( $R_{ISET}$ ) to ground. $I_{BAT} = \frac{1000 \times V_{ISET}}{R_{ISET}}$
3	GND	GND is the connection to system ground.
4	VIN	VIN is the input power source. Connect to a wall adapter.
5	BAT	BAT is the connection to the battery. Typically a 10 $\mu$ F Tantalum capacitor is needed for stability when there is no battery attached. When a battery is attached, only a 1uF ceramic capacitor is required.
6	STAT2	Open-Drain Charge Status Output. When the battery is charging, the STAT2 pin could be pulled High by an external pull high resistor. When the charge cycle is completed, the pin is pulled Low by an internal N-channel MOSFET.
7	STAT1	Open-Drain Charge Status Output. When the battery is charging, the STAT1 pin is pulled low by an internal NMOS. When the charge cycle is completed, the pin could be pulled High by an external pull high resistor.
8	EN	Charge Enable Input (active high).



### Function Block Diagram



### Absolute Maximum Ratings

- ✧ Input Voltage to GND ----- -0.3V to 28V
- ✧ BAT voltage GND ----- - 5V to 7V
- ✧ Other pin to GND ----- -0.3V to 6.5V
- ✧ Maximum Junction Temperature ----- 125°C
- ✧ Maximum Soldering Temperature (at leads, 10 sec) ----- 260°C
- ✧ Operating Junction Temperature Range (T<sub>J</sub>) ----- -40°C to 85°C
- ✧ Storage Temperature ----- -65°C to 165°C

### Thermal Information

- ✧ Maximum Power Dissipation ( P<sub>D</sub>, T<sub>A</sub>=25°C) ----- 2W
- ✧ Thermal Resistance (θ<sub>JA</sub>) ----- 50°C/W

### ESD Susceptibility

- ✧ HBM(Human Body Mode) ----- 2KV
- ✧ MM(Machine Mode) ----- 200V



## Electrical Characteristics

( $T_A=25^{\circ}\text{C}$ ,  $V_{IN}=5\text{V}$ , unless otherwise noted.)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP.	MAX	UNITS
$V_{IN}$	Input Voltage		4.4	5	6.5	V
$I_{IN}$	Input Supply Current	$I_{BAT}=0$		1000		$\mu\text{A}$
$V_{EN\_L}$	EN Logic-Low Voltage Threshold				0.4	V
$V_{EN\_H}$	EN Logic-High Voltage Threshold		1.4			V
$V_{FLOAT}$	Regulated Output (Float) Voltage	$I_{BAT}=40\text{mA}$ ,	4.158	4.2	4.242	V
$V_{UV}$	$V_{IN}$ Under Voltage Lockout Threshold	From $V_{IN}$ Low to High	3.1	3.3	3.5	V
$V_{UV\_HYS}$	$V_{IN}$ Under Voltage Lockout Hysteresis			150		mV
$V_{OVP}$	Input Voltage OVP	$V_{IN}$ Rising		7		V
$V_{OVP\_HYS}$	OVP Hysteresis			150		mV
$I_{BAT}$	BAT Pin Current	$R_{ISET}=1\text{k}$ , Current Mode		1000		$\text{mA}$
		$R_{ISET}=3.3\text{k}$ , Current Mode		300		$\text{mA}$
		$V_{BAT}=4.2\text{V}$		1		$\mu\text{A}$
		$V_{IN}=\text{float or }0\text{V}$		1		$\mu\text{A}$
$I_{TRIKL}$	Trickle Charge Current	$V_{BAT}<V_{TRIKL}$ , $R_{ISET}=1\text{k}$ , Current Mode		10		% $I_{BAT}$
$V_{TRIKL}$	Trickle Charge Threshold Voltage	$V_{BAT}$ Rising		2.6		V
$V_{TRHYS}$	Trickle Charge Hysteresis Voltage			150		mV
$I_{TERM}$	Termination Current Threshold			10		% $I_{BAT}$
$V_{ISET}$	ISET Pin Voltage	$R_{ISET}=10\text{k}$ , Current Mode		1		V
$I_{STAT}$	STAT1/STAT2 Pin Weak Pull-Down Current	$V_{STAT}=5\text{V}$			5	$\mu\text{A}$
$V_{STAT}$	STAT1/STAT2 Pin Output Low Voltage	$I_{STAT}=5\text{mA}$			0.1	V
$V_{NTC-0^{\circ}\text{C}}$	Low Temperature Pending Voltage Threshold			1.18		V
$V_{NTC-10^{\circ}\text{C}}$	Half Charging Current Mode Voltage Threshold (Low temperature)			0.75		V
$V_{NTC-60^{\circ}\text{C}}$	High Temperature Disable Voltage Threshold			0.17		V
$V_{NTC\_HYS}$	NTC Hysteresis Voltage			30		mV
$I_{NTC}$	NTC Bias Current	$R_{NTC}=10\text{K}$		48		$\mu\text{A}$
$V_{RECHRG}$	Recharge Voltage Threshold	$V_{IN}=5\text{V}$		4.05		V
$T_{LIM}$	Junction Temperature in Constant Temperature Mode			125		$^{\circ}\text{C}$



## Application Information

### Input Voltage Range

The LP28053A has built-in input voltage surge protection as high as +28V. The charger IC will be automatically disabled when the input voltage is lower than 3.3V or higher than 7.0V. A charge cycle begins when the voltage at the VIN pin rises above the 4.4V level, when a battery is connected to the charger output. If the BAT pin is less than 2.6V, the charger enters trickle charge mode. In this mode, the LP28053A supplies approximately 1/10 the ISET programmed charge current to bring the battery voltage up to a safe level for full current charging. When the BAT pin voltage rises above 2.6V, the charger enters constant-current mode(CC), where the ISET programmed charge current is supplied to the battery. When the BAT pin approaches the final float voltage, the LP28053A enters constant-voltage mode(CV) and the charge current begins to decrease, and the battery full indication is set when the charge current in the CV mode is reduced to the programmed full battery current (1/10).

### Charge Termination

A charge cycle is terminated when the charge current falls to 1/10th the ISET programmed value after the final float voltage is reached. This condition is detected by using an internal, filtered comparator to monitor the ISET pin. When the ISET pin voltage falls below 100mV for longer than  $t_{TERM}$  (typically 1ms), charging is terminated.

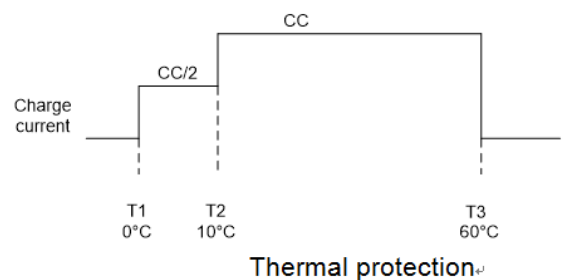
### ISET programming Charge Current

The charge current ( $I_{BAT}$ ) is set by a resistor ( $R_{ISET}$ ) connecting from the ISET pin to GND. The relationship of the charge current and the programming resistance is established by the following equations ( $V_{ISET}=1V$ ).

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

### Battery Temperature Sensing

The NTC function for the LP28053A is designed to follow the new JEITA temperature standard for Li-Ion and Li-Polymer batteries. There are three thresholds namely, 60°C, 10°C and 0°C. Normal operation occurs between 10°C and 60°C and battery is charged at 1C in CC mode. If between 0°C and 10°C, the battery is charged at C/2 in CC mode. Above 60°C or below 0°C, charging is disabled.



The NTC feature is implemented using an internal 48µA current source to bias the thermistor connected from the NTC terminal to GND(designed for use with a 10k NTC  $\beta=3370$  [SEMITEC 103AT-2 or Mitsubishi TH05-3H103F]). If NTC feature is not needed, a fixed 10kΩ can be placed between NTC and GND to allow normal operation. Since the  $I_{NTC}$  current is fixed along with the temperature thresholds, it is not possible to use thermistor values other than the 10k NTC (at 25°C).

### Enable Function

The LP28053A features an enable/disable function. An input “High” signal at EN pin or if this pin is floating will enable the IC. To assure the charger switch on, the EN turn on control level must above 1.4 volts. If the enable function is not needed in a specific application, it may be tied to VIN to keep the charge IC in a continuously on state.



### Automatic Recharge

Once the charge cycle is terminated, the LP28053A continuously monitors the voltage on the BAT pin. A charge cycle restarts when the battery voltage falls below 4.05V (which corresponds to approximately 80% to 90% battery capacity). This ensures that the battery is kept at or near a fully charged condition and eliminates the need for periodic charge cycle initiations.

### Charge Status Indicator(STAT1/STAT2)

The charge status output has two different states: strong pull-down (~5mA) and high impedance. After application of a 5V source, the input voltage rises above the 4.4V, but is less than OVP .The STAT1 strong pull-down state indicates that the LP28053A is in a charge cycle, STAT2 is in a high impedance. Once the charge cycle has terminated, STAT1 is in a high impedance, The STAT2 strong pull-down state.

Function	STAT1(pin7)	STAT2(pin6)
Charging	Low	High
Charge Finish	High	Low

### Thermal Limiting

An internal thermal feedback loop reduces the ISET programmed charge current if the die temperature attempts to rise above a preset value of approximately 125°C. This feature protects the LP28053A 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 LP28053A. 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.

### Power Dissipation

The conditions that cause the LP28053A to reduce charge current through thermal feedback can be approximated by considering the power dissipated in the IC. Nearly all of this power dissipation is generated by the internal MOSFET calculated to be approximately:

$$P_D = (V_{IN} - V_{BAT}) \times I_{BAT}$$

Where PD is the power dissipated, VIN is the input supply voltage, VBAT is the battery voltage and IBAT is the charge current. The approximate ambient temperature at which the thermal feedback begins to protect the IC is:

$$T_A = 125^\circ\text{C} - P_D \times \theta_{JA}$$

$$T_A = 125^\circ\text{C} - (V_{IN} - V_{BAT}) \times I_{BAT} \times \theta_{JA}$$

Example: An LP28053A operating from a 5V USB supply is programmed to supply 1000mA full-scale current to a discharged Li-Ion battery with a voltage of 3.75V. Assuming  $\theta_{JA}$  is 50°C / W (see Board Layout Considerations), the ambient temperature at which the LP28053A will begin to reduce the charge current is approximately:

$$T_A = 125^\circ\text{C} - (5\text{V} - 3.75\text{V}) \times (1000\text{mA}) \times 50^\circ\text{C}/\text{W}$$

$$T_A = 125^\circ\text{C} - 1.25\text{W} \times 50^\circ\text{C}/\text{W} = 125^\circ\text{C} - 62.5^\circ\text{C} \quad (T_A = 60^\circ\text{C})$$

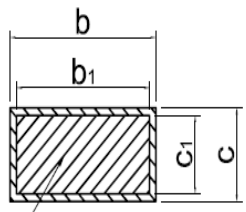
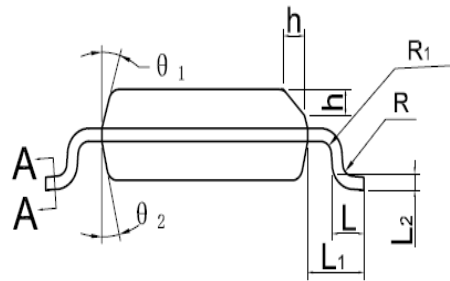
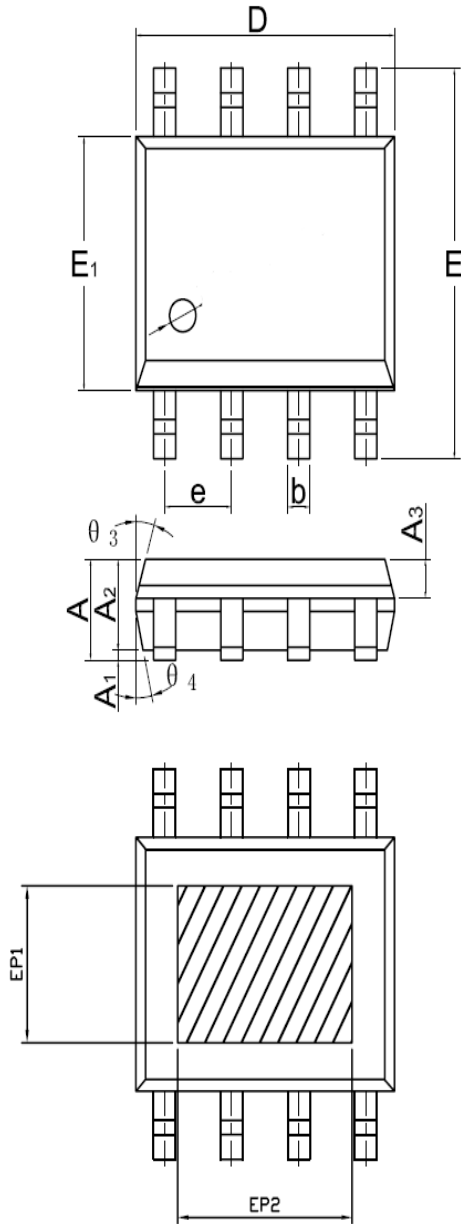
The LP28053A can be used above 60°C ambient, but the charge current will be reduced from 1000mA. The approximate current at a given ambient temperature can be approximated by:

$$I_{BAT} = (125^\circ\text{C} - T_A) / \theta_{JA} + (V_{IN} - V_{BAT})$$



Packaging Information

ESOP-8



BASE METAL

SECTION A-A  
6:1

DIMENSIONS IN MILLIMETERS

SYMBOL	MIN	NOM	MAX
A	1,35	1,55	1,75
A <sub>1</sub>	0,00	—	0,10
A <sub>2</sub>	1,25	1,40	1,65
A <sub>3</sub>	0,50	0,60	0,70
b	0,39	—	0,49
b <sub>1</sub>	0,28	—	0,48
c	0,10	—	0,25
c <sub>1</sub>	0,10	—	0,23
D	4,80	4,90	5,00
E	5,80	6,00	6,20
E <sub>1</sub>	3,80	3,90	4,00
e	1,27BSC		
L	0,45	—	1,00
L <sub>1</sub>	1,04REF		
L <sub>2</sub>	0,25BSC		
R	0,07	—	—
R <sub>1</sub>	0,07	—	—
h	0,3	0,4	0,5
	0°	—	8°
theta <sub>1</sub>	11°	17°	19°
theta <sub>2</sub>	11°	13°	15°
theta <sub>3</sub>	15°	17°	19°
theta <sub>4</sub>	11°	13°	15°
EP1	2,40	—	—
EP2	3,30	—	—