



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

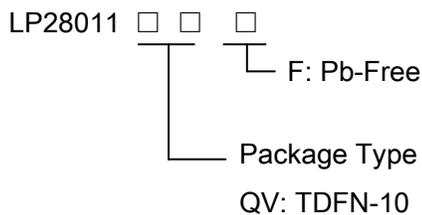
### General Description

The LP28011 is a complete constant-current / constant-voltage linear charger for single cell lithium-ion battery. Its TDFN-10 package and low external component count make the LP28011 ideally suited for portable applications. No external sense resistor is needed, and no blocking diode is required due to the internal MOSFET architecture. The charge voltage is fixed at 4.2V, and the charge current can be programmed externally with a single resistor( $R_{ISET}$ ).

The LP28011 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 LP28011 automatically enters a low current state, dropping the battery drain current to less than 1 $\mu$ A.

### Order Information



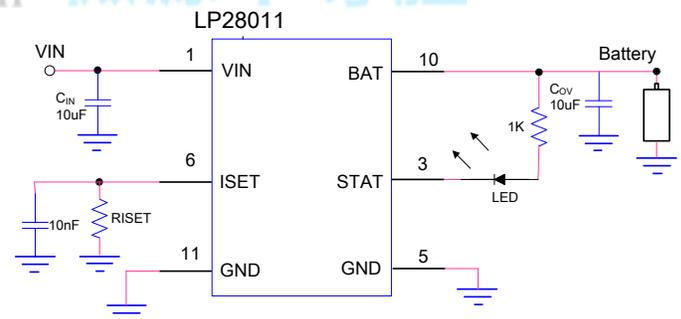
### Applications

- ✧ 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 :300mA to 1A
- ◆ < 1 $\mu$ 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
- ◆ TDFN-10 Package
- ◆ RoHS Compliant and 100% Lead (Pb)-Free

### Typical Application Circuit



### Marking Information

Device	Marking	Package	Shipping
LP28011QVF	LPS LP28011 YWX	TDFN-10	5K/REEL
Marking indication: Y:Production year W:Production week X: Series Number			



## Functional Pin Description

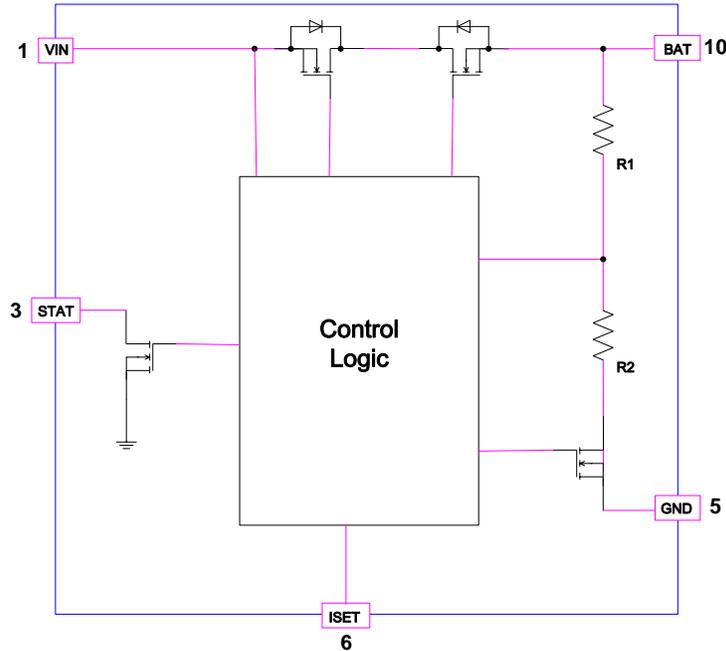
Package Type	Pin Configurations
TDFN-10	<p style="text-align: center;">TDFN-10 TOP VIEW</p>

## Pin Description

Pin	Name	Description
1	VIN	VIN is the input power source. Connect to a wall adapter.
2,4,7,8,9	NC	No Connector.
3	STAT	Open-Drain Status Output. When the battery is charging, the STAT pin is pulled low by an internal N-channel MOSFET.
5,11(PAD)	GND	GND is the connection to system ground.
6	ISET	Charge Current Program.
10	BAT	BAT is the connection to the battery. Typically a 10μF Tantalum capacitor is needed for stability when there is no battery attached. When a battery is attached, only a 0.1μF ceramic capacitor is required.



### 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
- ◇ Storage Temperature ----- -45°C to 150°C

### Thermal Information

- ◇ Maximum Power Dissipation ( $P_D, T_A=25^\circ\text{C}$ ) ----- 1.5W
- ◇ Thermal Resistance ( $\theta_{JA}$ ) ----- 65°C/W

### ESD Susceptibility

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

**Note 1.** Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### Recommended Operating Conditions

- ◇ Input supply voltage ----- 4.4V to 6.5V
- ◇ Operating Ambient Temperature Range ----- -40°C to 85°C



## Electrical Characteristics

(TA = 25°C. VIN = 5V, unless otherwise noted.)

Symbol	Parameter	Condition	Min	Typ	Max	Units
V <sub>IN</sub>	Input Voltage		4.4	5	6.5	V
I <sub>IN</sub>	Input Supply Current	I <sub>BAT</sub> = 0		1000		uA
V <sub>FLOAT</sub>	Regulated Output (Float) Voltage	I <sub>BAT</sub> = 40mA,	4.158	4.2	4.242	V
V <sub>UV</sub>	V <sub>IN</sub> Under voltage Lockout Threshold	From V <sub>IN</sub> Low to High	3.1	3.3	3.5	V
V <sub>UVHYS</sub>	V <sub>IN</sub> Under voltage Lockout Hysteresis			150		mV
V <sub>OV</sub>	Input Voltage Over Voltage Protection	V <sub>IN</sub> Rising	6.7	7	7.3	V
V <sub>OV-HYS</sub>	Over Voltage Protection Hysteresis			0.2		V
I <sub>BAT</sub>	BAT Pin Current	R <sub>ISET</sub> = 1.5k, Current Mode		1000		mA
		V <sub>BAT</sub> = 4.2V, V <sub>IN</sub> =float or 0V		1		uA
I <sub>TRIKL</sub>	Trickle Charge Current	V <sub>BAT</sub> < V <sub>TRIKL</sub> , R <sub>ISET</sub> = 1.5k, Current Mode		10		%I <sub>BAT</sub>
V <sub>TRIKL</sub>	Trickle Charge Threshold Voltage	V <sub>BAT</sub> Rising		2.6		V
V <sub>TRHYS</sub>	Trickle Charge Hysteresis Voltage			150		mV
I <sub>TERM</sub>	Termination Current Threshold			10		%I <sub>BAT</sub>
V <sub>ISET</sub>	ISET Pin Voltage	R <sub>ISET</sub> = 10k, Current Mode		1		V
I <sub>STAT</sub>	STAT Pin Weak Pull-Down Current	V <sub>STAT</sub> = 5V			5	uA
V <sub>STAT</sub>	STAT Pin Output Low Voltage	I <sub>STAT</sub> = 5mA			0.1	V
V <sub>RESTAT</sub>	Recharge Voltage Threshold	V <sub>IN</sub> = 5V		4.05	.	V
T <sub>LIM</sub>	Junction Temperature in Thermal Protection			125		°C



## Application Information

### Input Voltage Range

The LP28011 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. If the input voltage is lower than the battery voltage, the IC is also disabled to prevent the battery from draining.

A charge cycle begins when the voltage at the VIN pin rises above the UVLO threshold 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 LP28011 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 R<sub>ISET</sub> programmed charge current is supplied to the battery. When the BAT pin approaches the final float voltage, the LP28011 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 1/10 of the R<sub>ISET</sub> programmed charge current.

### ISET programming Charge Current

The charge current (I<sub>BAT</sub>) is set by a resistor (R<sub>ISET</sub>) connecting from the ISET pin to GND. The relationship of the charge current and the programming resistance is established by the following table.

R <sub>ISET</sub> (KΩ)	I <sub>BAT</sub> (mA)
1.3	1150
1.5	1000
2	700
3.3	420

### Automatic Recharge

Once the charge cycle is terminated, the LP28011 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.

### Thermal Limiting

An internal thermal feedback loop reduces the I<sub>SET</sub> programmed charge current if the die temperature attempts to rise above a preset value of approximately 125°C. This feature protects the LP28011 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 LP28011. 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.



### Charge Status Indicator

STAT has two different states: strong pull-down (~5mA) and high impedance. The strong pull-down state indicates that the LP28011 is in a charge cycle. Once the charge cycle has terminated, the pin state is determined by under voltage lockout conditions. High impedance indicates that the LP28011 is in under voltage lockout mode: either  $V_{IN}$  is less than 100mV above the BAT pin voltage or insufficient voltage is applied to the VIN pin.

Function	STAT
Charging	Low
Charge Complete	High

### Power Dissipation

The conditions that cause the LP28011 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  $P_D$  is the power dissipated,  $V_{IN}$  is the input supply voltage,  $V_{BAT}$  is the battery voltage and  $I_{BAT}$  is the charge current. The approximate ambient temperature at which the thermal feedback begins to protect the IC is:

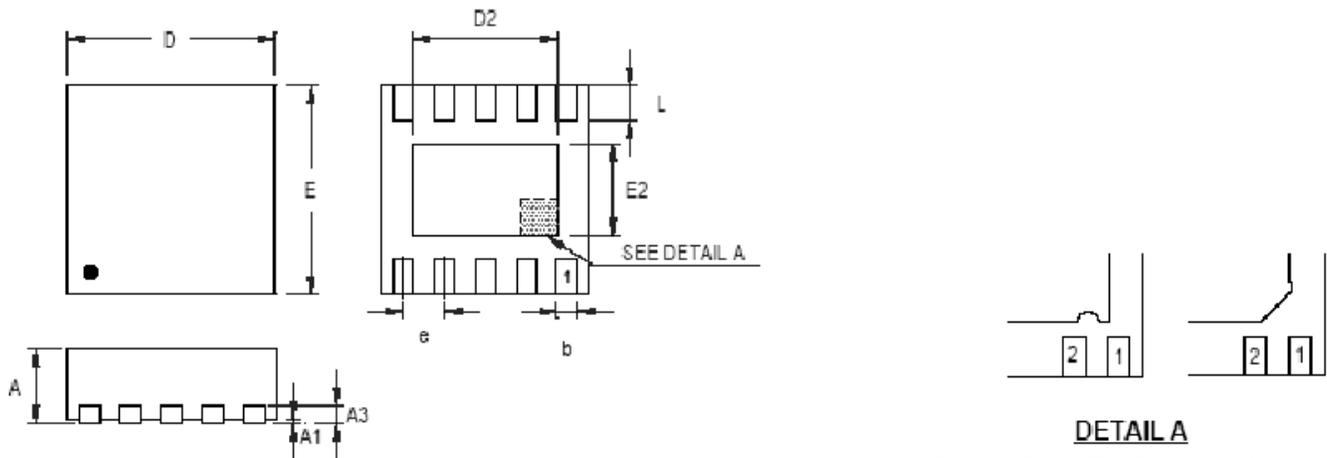
$$T_A = 125^\circ\text{C} - P_D \times \theta_{JA}$$





## Packaging Information

### TDFN-10



#### DETAIL A

Pin #1 ID and Tie Bar Mark Options

Note : The configuration of the Pin #1 identifier is optional, but must be located within the zone indicated.

Symbol	Dimensions in millimeters		Dimensions in inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.175	0.250	0.007	0.010
b	0.180	0.300	0.007	0.012
D	2.950	3.050	0.116	0.120
D2	2.300	2.650	0.091	0.104
E	2.950	3.050	0.116	0.120
E2	1.500	1.750	0.059	0.069
e	0.500		0.020	
L	0.350	0.450	0.014	0.018