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

General Description

The LP4066 is a complete constant-current/ constant voltage linear charger for single cell lithium-ion battery. Its SOT23-5/TDFN-8/ESOP8 package and low external component count make the LP4066 ideally suited for portable applications.

The charge current and termination current could program by external resistors. While the battery voltage is lower than 2.6V, the charge current is typically 10% of the programmed charge current. During the constant voltage phases, if the charge current reduces to the termination current level, the device will disable the internal power MOS and CHRG goes high impedance, which signals the charge cycle is termination.

When the input supply is removed, the LP4066 automatically enters a low current state, dropping the battery drain current to less than 1μA.

Other features include charge current monitor, under voltage lockout, automatic recharge and a status pin to indicate charge termination and the presence of an input voltage.

Order Information

LP4066 □□ □-□□□

- Charge Voltage
  - Default: 4.2V
  - 435: 4.35V
  - 44: 4.4V
- F: Pb-Free
- Package Type
  - QV: TDFN-8
  - SP: ESOP8
  - B5: SOT23-5

Features

- Input Voltage up to 36V
- Battery Maximum Voltage up to 15V
- Input Over Voltage Protection：6.3V
- Short-circuit protection
- Programmable Charge Current up to 1000mA
- <0.1μA 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
- SOT23-5 /TDFN-8/ESOP8 Package
- RoHS Compliant and 100% Lead (Pb)-Free

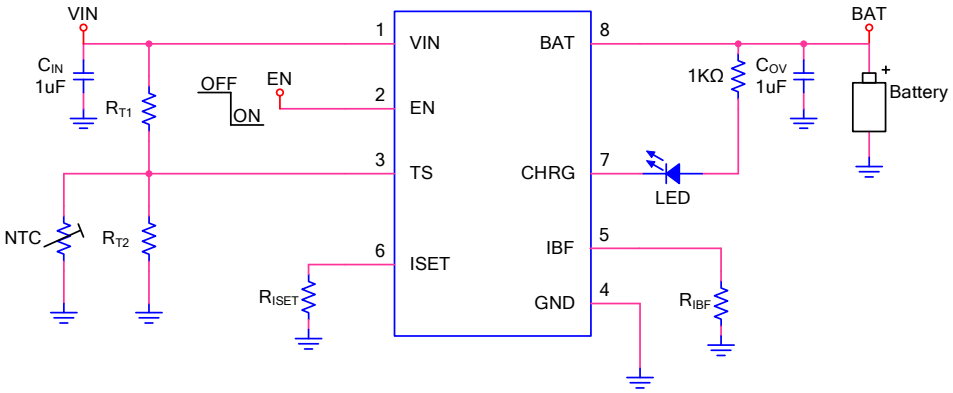
Applications

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

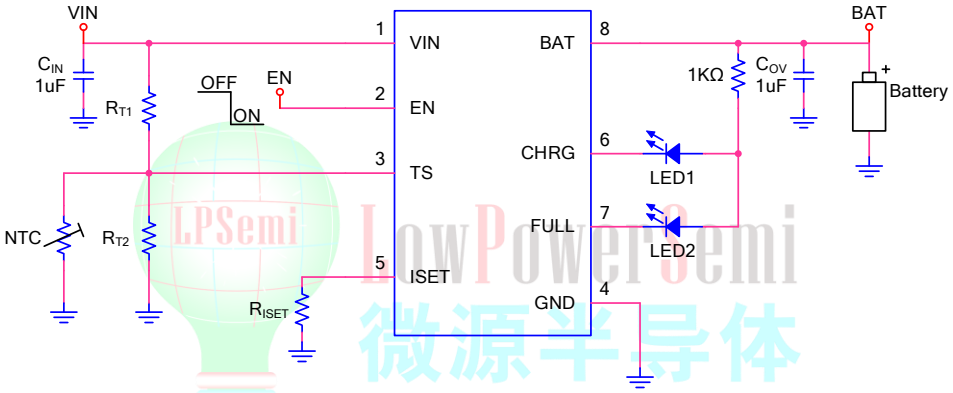
Marking Information

Device	Marking	Package	Shipping
LP4066B5F	LP4066 9XYWX	SOT23-5	3K/RELL
LP4066QVF	LPS LP4066 YWX	TDFN-8	4K/RELL
LP4066QVF-435	LPS LP4066 435YWX	TDFN-8	4K/RELL
LP4066QVF-44	LPS LP4066 44YWX	TDFN-8	4K/RELL
LP4066SPF	LPS LP4066 YWX	ESOP8	4K/RELL
LP4066SPF-435	LPS LP4066 YWX	ESOP8	4K/RELL
Marking indication: Y:Production year W:Production week X: Series Number			

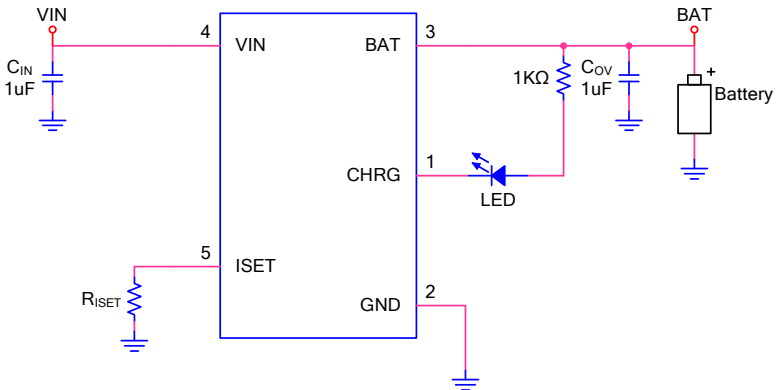
Typical Application Circuit



LP4066QVF

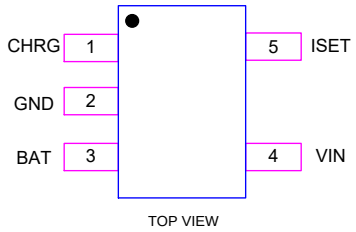
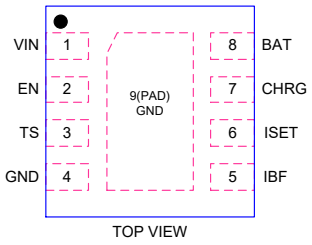
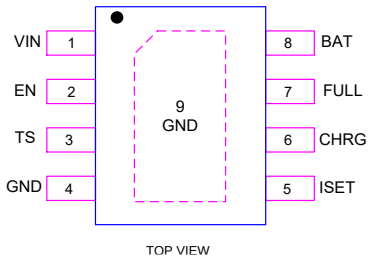


LP4066SPF



LP4066B5F

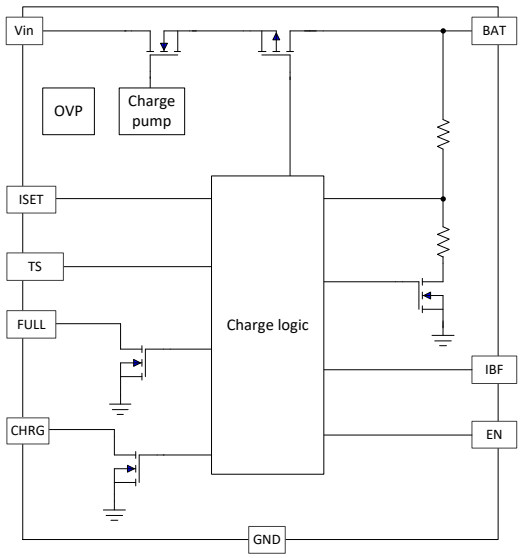
Functional Pin Description

Package Type	SOT23-5	TDFN-8	ESOP8
Pin Configurations			

Pin Description

NAME	Pin No.			DESCRIPTION
	TDFN-8	SOT23-5	ESOP8	
VIN	1	4	1	VIN is the input power source. Connect to a wall adapter.
EN	2	-	2	Charge Enable Input (active low).
TS	3	-	3	Temperature detection pin
GND	4	2	4	GND is the connection to system ground.
IBF	5	-	-	Termination Current Program.
ISET	6	5	5	Charge Current Program. The charge current is programmed by connecting a 1% resistor(R_{ISET}) to ground. $$I_{BAT} = \frac{1700 \times V_{ISET}}{R_{ISET}}$$
CHRG	7	1	6	Open-Drain Charge Status Output. When the battery is charging, the CHRG 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.
FULL	-	-	7	Open-Drain Charge Status Output. When the battery is charging, the FULL 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.
BAT	8	3	8	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 1uF ceramic capacitor is required.

Function Block Diagram



Absolute Maximum Ratings Note 1

- ✧ Input Voltage to GND ---------- -0.3V to 36V
- ✧ BAT Voltage GND ---------- - 5V to 15V
- ✧ Other pin to GND ---------- -0.3V to 6.5V
- ✧ Maximum Junction Temperature ---------- 150℃
- ✧ Maximum Soldering Temperature (at leads, 10 sec) ---------- 260℃
- ✧ Storage Temperature ---------- -60℃ to 125℃

Thermal Information

- ✧ Maximum Power Dissipation (P_D,T_A=25°C) ---------- 0.6W
- ✧ Thermal Resistance (θ_{JA}) ---------- 200℃/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

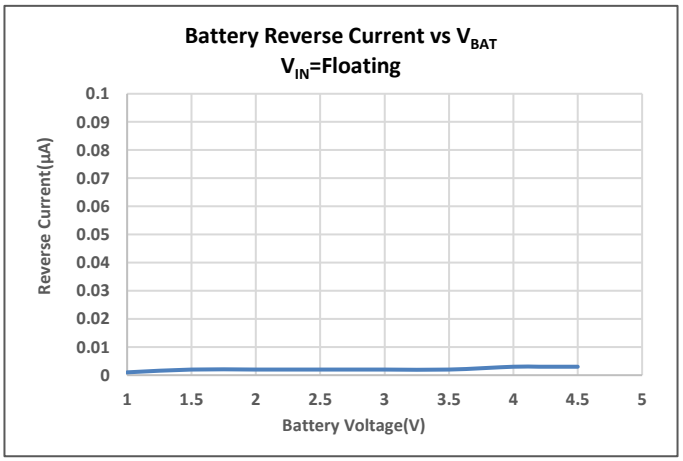
- ✧ Input supply voltage ---------- 4.5V to 5.8V
- ✧ Operating Ambient Temperature Range ---------- -40℃ to 85℃

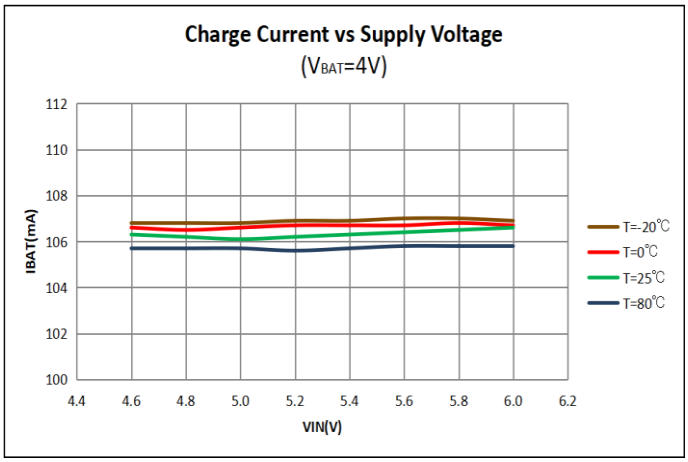
Electrical Characteristics

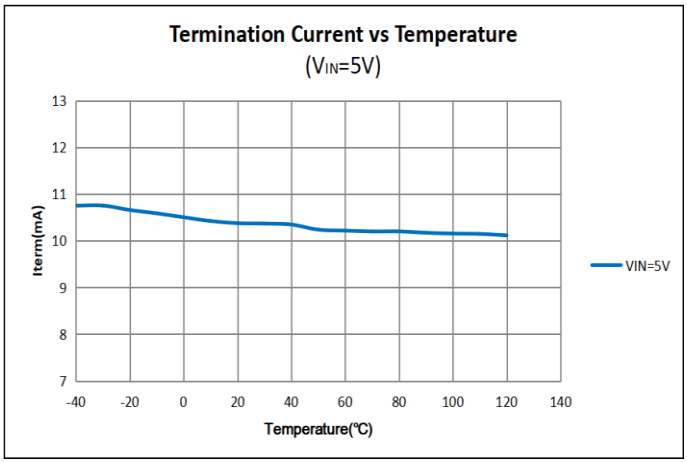
(T_A=25°C, V_{IN} =5V, unless otherwise noted.)

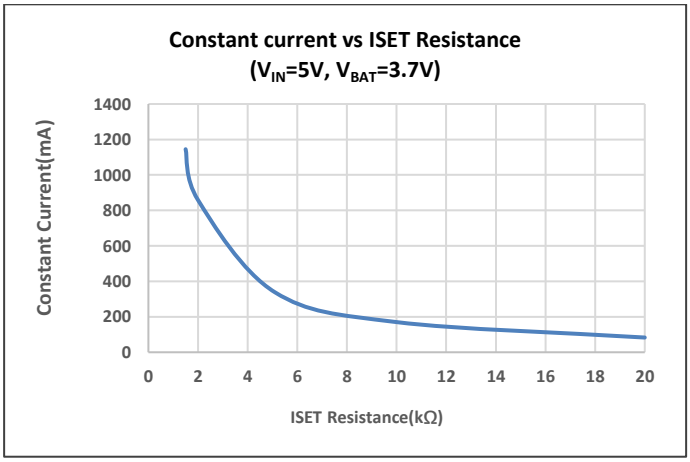
SYMBOL	PARAMETER	CONDITIONS	MIN	TYP.	MAX	UNITS
I_{IN}	Input Supply Current	I_{BAT}=4.2V		250		uA
V_{EN_ON}	EN Logic-Low Voltage Threshold				0.4	V
V_{EN_OFF}	EN Logic-High Voltage Threshold		1.4			V
V_{FLOAT}	Regulated Output (Float) Voltage	I_{BAT}=40mA,,LP4066XXX	4.158	4.2	4.242	V
		I_{BAT}=40mA,,LP4066XXX-435	4.307	4.35	4.3935	V
		I_{BAT}=40mA,,LP4066XXX-44	4.356	4.4	4.444	V
V_{UV}	VIN Under Voltage Lockout Threshold	From V_{IN} Low to High		3.5		V
V_{OVP}	Input Voltage OVP	V_{IN} Rising		6.3		V
V_{OVP_HYS}	OVP Hysteresis			300		mV
I_{BAT}	BAT Pin Current	R_{ISET}=3.4k, Current Mode		500		mA
		R_{ISET}=17k, Current Mode		100		mA
		V_{IN}=float		0.1		uA
I_{TRIKL}	Trickle Charge Current	V_{BAT}<V_{TRIKL} , R_{ISET}=10k, 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	LP4066B5F/LP4066SPF		10		%I_{BAT}
		LP4066QVF	5		90	%I_{BAT}
V_{ISET}	ISET Pin Voltage	R_{ISET}=10k, Current Mode		1		V
I_{STAT}	CHRG/FULL Pin Sink Current				5	mA
V_{CHRG}	CHRG Pin Output Low Voltage	I_{CHRG}=5mA			0.1	V
V_{TS_H}	TS high voltage thresholds	LP4066QVF/LP4066SPF		60		%V_{IN}
V_{TS_L}	TS low voltage thresholds	LP4066QVF/LP4066SPF		30		%V_{IN}
V_{TS_HYS}	TS voltage hysteresis	LP4066QVF/LP4066SPF		30		mV
ΔV_{RECHRG}	Recharge Battery Threshold Voltage	V_{FLOAT}-V_{RECHRG}		150		mV
R_{DS}	VIN to BAT ON-Resistance	RISET=1.7kΩ,VBAT=3.5V		600		mΩ
T_{LIM}	Junction Temperature in Constant Temperature Mode			145		°C

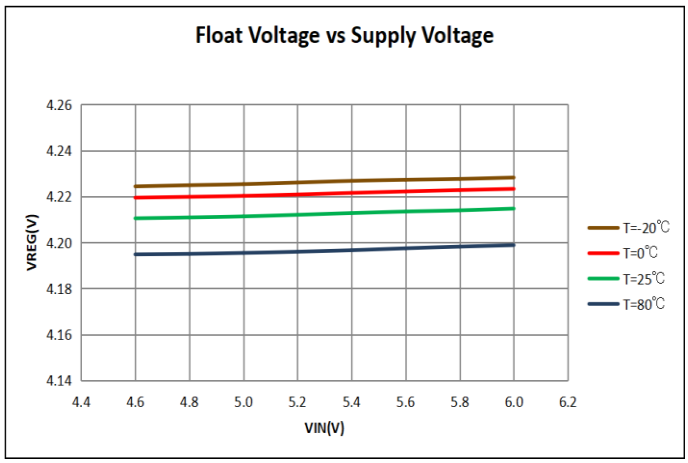
Typical Performance Characteristics

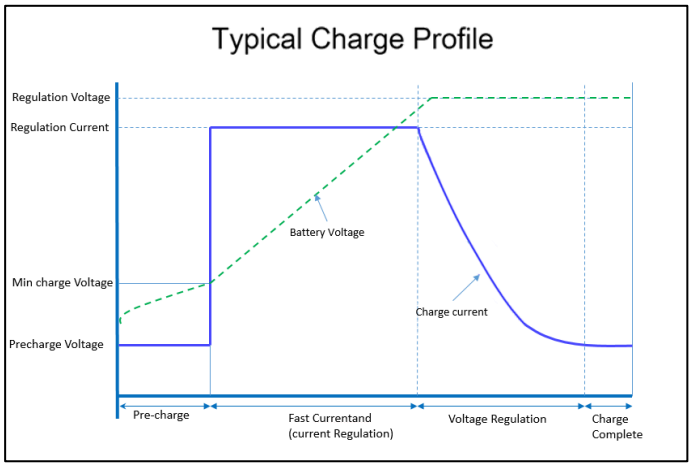












Application Information

Input Voltage Range

The LP4066 device is a highly advanced linear charger with up to 1A maximum charge current for single cell Li-Ion and Li-Polymer battery. The device charges the battery in three modes: trickle current mode, constant current mode and constant voltage mode.

When the battery voltage is lower than trickle charge threshold voltage 2.6V (typical), the device is in trickle current mode, the charge current will be set as approximately 10% of the ISET programmed current to bring the battery voltage up to a safe level for full current charging. When the battery voltage rises to be higher than trickle charge threshold voltage, the device enters the constant current mode, where the charge current is 100% of the ISET programmed current. When the battery voltage approaches the float voltage, the device goes to constant voltage mode, the charge current starts to decrease. When the charge current is lower than the IBF programed termination current threshold, the device will terminate the charging.

The device will automatically recharge the battery while the battery voltage drops 150mV (typical, ΔVRECHRG) from the float voltage.

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）.

$$I_{BAT} = \frac{1700 \times V_{ISET}}{R_{ISET}}$$

Termination Charge Current Programmed (LP4066QVF)

The battery charge Termination current threshold (IBF) is programmed by connecting a resistor RIBF from the IBF pin to GND:

$$I_{TERM} = \frac{R_{ISET} \times I_{BAT}}{R_{IBF}}$$

Battery Temperature Detection (LP4066QVF/LP4066SPF)

An internal resistor divider sets the low temperature threshold (VTS_L) and high temperature threshold (VTS_H) at 60% of VIN and 30% of VIN, respectively. For a given TS thermistor, select an appropriate RT1 and RT2 to set the TS window with following equation:

$$\frac{V_{TS\_L}}{V_{IN}} = \frac{R_{T2} \parallel R_{TS\_COLD}}{R_{T1} + R_{T2} \parallel R_{TS\_COLD}} = T_L = 60\%$$

$$\frac{V_{TS\_H}}{V_{IN}} = \frac{R_{T2} \parallel R_{TS\_HOT}}{R_{T1} + R_{T2} \parallel R_{TS\_HOT}} = T_H = 30\%$$

Where RTS_HOT is the value of the TS resistor at the upper bound of its operating temperature range, and RTS_COLD is its lower bound. The two resistors RT1 and RT2 determine the upper and lower temperature limits independently. This flexibility allows the IC to operate with most TS resistors for different temperature range requirements. Calculate RT1 and RT2 with following equation:

$$R_{T1} = \frac{R_{TS\_HOT} \times R_{TS\_COLD} \times (T_L - T_H)}{T_H \times T_L \times (R_{TS\_COLD} - R_{TS\_HOT})}$$

$$R_{T2} = \frac{R_{TS\_HOT} \times R_{TS\_COLD} \times (T_L - T_H)}{(1 - T_L) \times T_H \times R_{TS\_COLD} - (1 - T_H) \times T_L \times R_{TS\_HOT}}$$

Undervoltage Lockout (UVLO)

An internal UVLO circuit monitors the input voltage and keeps the device in Shutdown mode until the input supply rises above the UVLO threshold. The UVLO circuitry has a built-in hysteresis of 170 mV. Again, the input supply must rise to a level 150 mV above the battery voltage before the LP4066 become operational. The UVLO circuit is always active. Whenever the input supply is below the UVLO threshold or within +150 mV of the voltage at the VBAT pin, the LP4066 are placed in Shutdown mode. During any UVLO condition, the battery reverse discharge current is less than 0.1 μA.

Enable Function

The LP4066 features an enable/disable function. An input "Low" signal or floating connection on EN pin will enable the device. To ensure the device be active, the EN low voltage level must be lower than 0.4V. The device will enter the shutdown mode when the voltage on the EN pin is higher than 1.4V. If the enable function is not needed in a specific application, the EN pin could be shorted to GND or floating to keep the device continuously active.

Automatic Recharge

Once the charge cycle is terminated, the LP4066 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(CHRG/FULL)

After application of a 5V source, the input voltage rises above the UVLO and sleep thresholds (VIN>VBAT+VDT), but is less than OVP (VIN<VOVP), then the PG turns on and provides a low impedance path to ground.

CHRG has two different states: strong pull-down (~5mA) and high impedance. The strong pull-down state indicates that the LP4066A is in a charge cycle. When the charger is entered CV mode and once the charge current has reduced to the battery full charge current threshold (I_{TERM}), the CHRG pin will become high impedance.

Function	CHRG	FULL
Charging	Low	High
Charge Finish	High	Low

Thermal Limiting

An internal thermal feedback loop reduces the I_{SET} programmed charge current if the die temperature attempts to rise above a preset value of approximately 145°C. This feature protects the LP4066 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 LP4066. 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 LP4066 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:

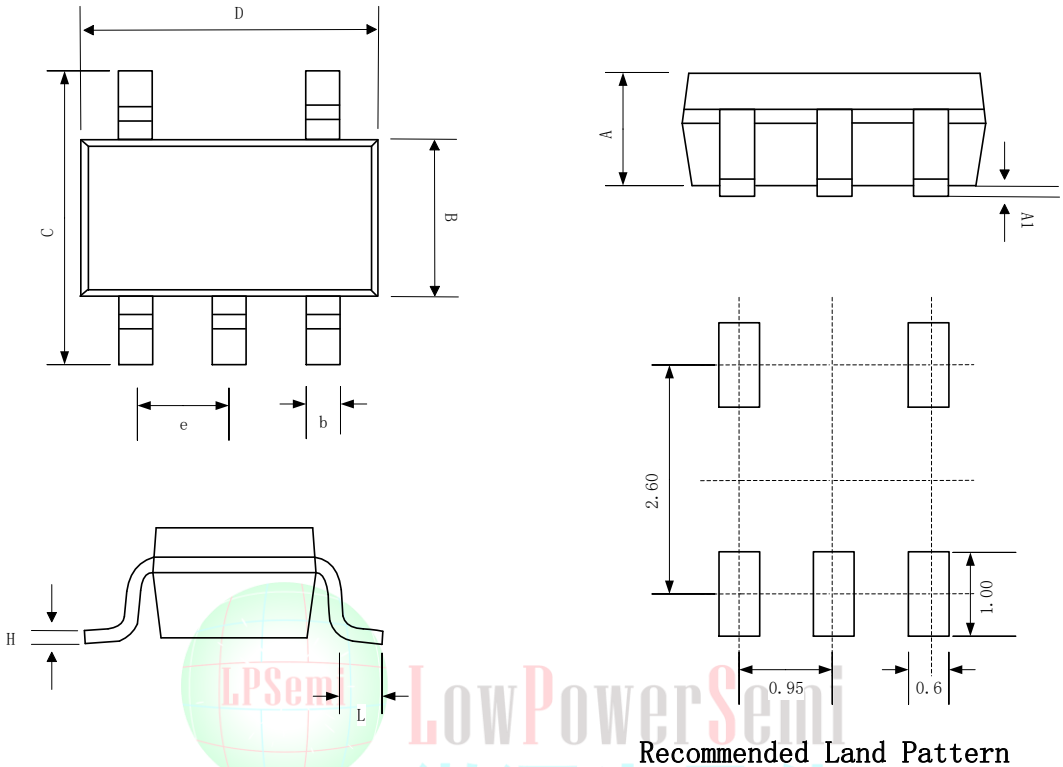
$$P_D = (V_{IN} - V_{BAT}) \times I_{BAT}$$

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:

$$T_A = 145℃ - P_D \times \theta_{JA}$$

Packaging Information

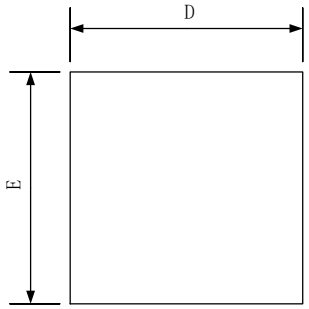
SOT23-5



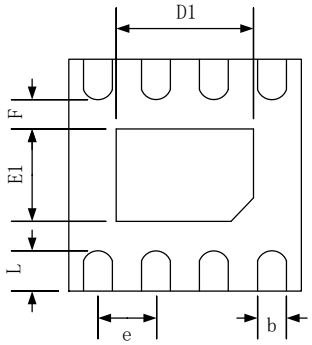
Recommended Land Pattern

SYMBOL	Dimensions In Millimeters		
	MIN	NOM	MAX
A	0.889	1.100	1.295
A1	0.000	0.050	0.152
B	1.397	1.600	1.803
b	0.28	0.35	0.559
C	2.591	2.800	3.000
D	2.692	2.920	3.120
e	0.95BSC		
H	0.080	0.152	0.254
L	0.300	0.450	0.610

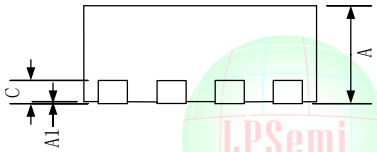
TDFN-8(2*2)



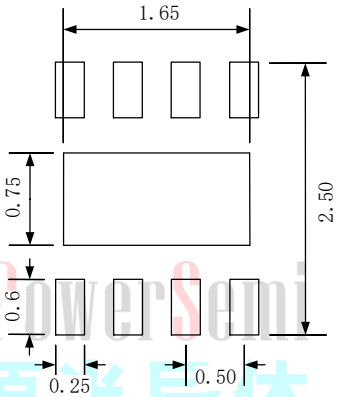
TOP VIEW



BOTTOM VIEW



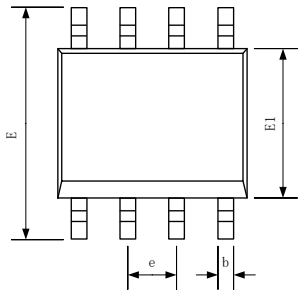
SIDE VIEW



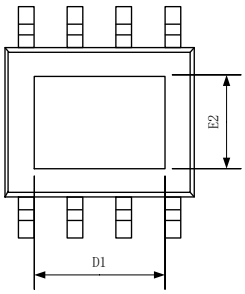
Recommended Land Pattern

SYMBOL	Dimensions In Millimeters		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
b	0.18	0.25	0.30
c		0.20 REF	
D	1.90	2.00	2.10
D1	1.10	1.30	1.65
E	1.90	2.00	2.10
E1	0.60	0.75	0.85
e		0.50 BSC	
L	0.25	0.35	0.40
F	0.25	0.30	0.35

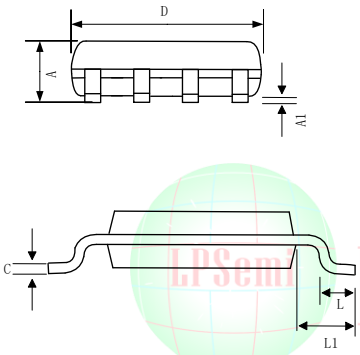
ESOP8



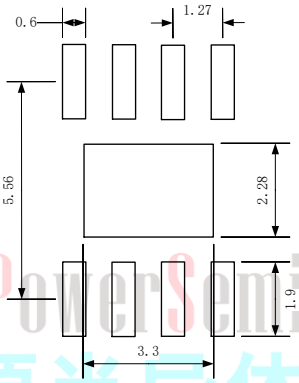
TOP VIEW



BOTTOM VIEW



SIDE VIEW



Recommended Land Pattern

SYMBOL	Dimensions In Millimeters		
	MIN	NOM	MAX
A	1.35	-	1.75
A1	0.00	-	0.15
b	0.30	0.40	0.50
c		0.20 REF	
D	4.70	4.90	5.10
D1		3.2 REF	
E	5.70	6.00	6.30
E1	3.70	3.90	4.10
E2		2.30 REF	
e		1.27 BSC	
L	0.40	0.60	0.80
L1		1.05 REF	