2A Synchronous Buck Li-ion Charger

General Description

The LP4020 is a 2A Li-ion battery charger. It utilizes a 600KHz synchronous buck converter topology to reduce power dissipation during charging. Low power dissipation and internal MOSFET allow a physically small charger that can be embedded in a wide range of handheld applications. The LP4020 includes complete charge termination circuitry, automatic recharge and ±1% 4.2V float voltage.

Additional features include shorted cell detection; temperature qualified charging and overvoltage protection. The LP4020 is available in a low profile SOT23-6/ESOP8 package.

Features

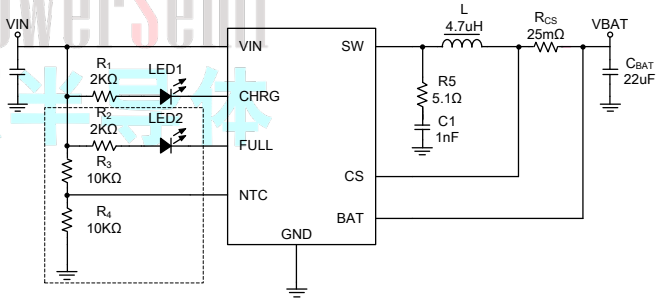
- Input voltage range 4.5V~5.5V
- Dynamic input current allocation for maximum charging rate
- 2A Maximum Charge Current
- No External MOSFETs and Blocking Diode Required
- Efficiency up to 90%
- Constant-Current/Constant-Voltage Charger
- Over Current Protection
- Consumption Available in SOT23-6/ESOP8
- RoHS Compliant and 100% Lead (Pb)-Free

Order Information

LP4020 □□ □

- F: Pb-Free
- Package Type
  - B6 : SOT23-6
  - SP : ESOP8

Typical Application Circuit



The C_{IN} must be as close as possible to the chip.

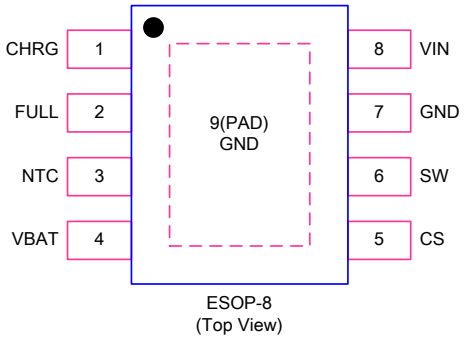
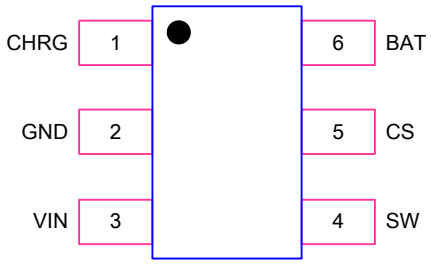
Applications

- Portable Media Players
- Cellular and Smart mobile phone
- PDA/DSC
- Handheld Battery-Powered Devices
- Handheld Computers
- Charging Docks and Cradles

Marking Information

Device	Marking	Package	Shipping
LP4020B6F	LP4020 YWXXX	SOT23-6	3K/REEL
LP4020SPF	LPS LP4020 YWXXX	ESOP8	4K/REEL
Marking indication: Y:Production year W:Production week X: Series Number			

Functional Pin Description

Package Type	ESOP8	SOT23-6
Pin Configurations	 ESOP-8 (Top View)	 SOT23-6 (Top View)

Pin Description

Name	Pin No.		Description
	ESOP8	SOT23-6	
CHRG	1	1	Open-Drain charge status output. When the battery is charging, this pin is pulled low by an internal N-channel MOSFET.
FULL	2	-	Open-Drain charge status output. When charging is complete, this pin is pulled low by an internal N-channel MOSFET.
NTC	3	-	Negative Temperature Coefficient Thermistor Input. This pin senses the temperature of the battery pack and stops the charger when the temperature is out of range. Connect to GND for disabling this function.
BAT	4	6	Battery pin.
CS	5	5	Current Sense pin.
SW	6	4	Switch pin. Connect to external inductor.
GND	7/9	2	Ground.
VIN	8	3	Positive Supply Voltage Input. Decouple with a 22μF or larger surface mounted ceramic capacitor.

Absolute Maximum Ratings Note 1

- ✧ IN pin to GND ---------- 7V
- ✧ BAT pin to GND ---------- 7V
- ✧ Other pin to GND ---------- 7V
- ✧ Maximum Junction Temperature(T_J) ---------- 150℃
- ✧ Maximum Soldering Temperature (at leads, 10 sec) ---------- 260℃

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.

Thermal Information

- ✧ Maximum Power Dissipation (SOT23-6, P_D, T_A=25℃) ---------- 0.6W
- ✧ Thermal Resistance (SOT23-6, θ_{JA}) ---------- 195℃/W
- ✧ Maximum Power Dissipation (ESOP8, P_D, T_A=25℃) ---------- 2W
- ✧ Thermal Resistance (ESOP8, θ_{JA}) ---------- 50℃/W

Recommended Operating Conditions

- ✧ Ambient Temperature Range ---------- -20℃ to 85℃

ESD Susceptibility

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

Electrical Characteristics

(The specifications which apply over the full operating temperature range, otherwise specifications are at T_A=25℃, V_{IN} = 5V, unless otherwise noted.)

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{IN}	Adapter/USB Voltage Range		4.5		5.5	V
I_{CC}	Input Supply Current	Standby Mode (Charge Terminated)		0.1		mA
V_{FLOAT}	Regulated Output (Float) Voltage		4.158	4.2	4.242	V
V_{CS}	Current Sense Reference Voltage (For CS to BAT)	$V_{TRIKL}<V_{BAT}<V_{FLOAT}$		50		mV
I_{BAT}	BAT Pin Current	R_{cs}=50mΩ, Current Mode		1000		mA
		R_{cs}=25mΩ, Current Mode		2000		mA
		Standby Mode			1.5	μA
I_{TRIKL}	Trickle Charge Current	$1V<V_{BAT}<V_{TRIKL}$, R_{CS}=50mΩ		100		mA
V_{TRIKL}	Trickle Charge Threshold Voltage	R_{CS}=50mΩ, V_{BAT} Rising		2.8		V
V_{TRHYS}	Trickle Charge Hysteresis Voltage	R_{CS}=50mΩ		100		mV
V_{REG}	Input Regulation Voltage			4.4		V
V_{STAT}	CHRG/FULL Pin Output Low Voltage	I_{CHRG}=5mA			0.5	V
ΔV_{RECHRG}	Recharge Threshold Voltage	V_{FLOAT}-V_{RECHRG}		150		mV
T_{LIM}	Junction Temperature in Constant Temperature Mode			135		℃
I_{TERM}	C/10 Terminal Current	R_{CS}=50mΩ		100		mA
UVLO	Under Voltage Lockout of VIN	V_{IN} rising		4.1		V
		V_{IN} falling		3.9		V
V_{OVP}	Over Voltage Protection of V_{IN}	V_{IN} rising		6.0		V
		V_{IN} falling		5.7		V
F_{OSC}	Switch Frequency	V_{IN}=5V, Current Mode		600		KHz
V_{NTC_C}	Protection Threshold Voltage of V_{NTC} rising (Cold)			80		%V_{IN}
V_{NTC_H}	Protection Threshold Voltage of V_{NTC} falling (Hot)			45		%V_{IN}
V_{NTC-D}	NTC Disable Voltage				100	mV

Application Information

LP4020 is a 2A synchronous buck Li-ion battery charger integrates 600KHz switching frequency and full protection functions. The charge current up to 2A can be programmed by using the external resistor for different portable applications and indicates the charger current information simultaneous.

In constant current mode, the charge current is set by the external sense resistor R_{CS} and an internal 50mV reference;

$$I_{BAT}=V_{cs}/R_{CS}=50mV/R_{CS}$$

When the battery voltage approaches the programmed float voltage, the charge current will start to decrease. When the current drops to 10% of the full-scale charge current, an internal comparator turns off the charger.a charge cycle is terminated.

Input Source Qualification

After REG amplifier powers up, the LP4020 checks the current capability of the input source. The input source has to meet the V_{IN}>4.4V to enable the chip.

Inductor Selection

Operating frequency was chosen for the buck switcher in order to minimize the size of the inductor. However, take care to use inductors with low core loss at this frequency. To calculate the inductor ripple current:

$$\Delta I_L = \frac{V_{BAT} - \frac{V_{BAT}^2}{V_{IN}}}{L \times f}$$

Automatic Recharge

Once the charge cycle is terminated, the LP4020 continuously monitors the voltage on the BAT pin using a comparator with a 1.8ms filter time ($t_{RECHARGE}$). 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)

When the input voltage is aboveV_{REG}, but lower than V_{OVP} (V_{IN}<V_{OVP}), CHRG and FULL pins have two different states: strong pull-down (~5mA) and high impedance. The strong pull-down state of CHRG implemented by an internal NMOS indicates that the LP4073H is in a charge cycle. After the charge current decreased to ITERM in CV mode and then charging terminated, the CHRG pin will become high impedance, the FULL pin will become pull-down state.

Function	CHRG	FULL
Charging	Low	Hi-Z
Charge Terminated	Hi-Z	Low

Battery Temperature Detection

The LP28303A continuously monitors temperature by measuring the voltage between the NTC and GND pins. A negative or a positive temperature coefficient thermistor (NTC, PTC) and an external voltage divider typically develop this voltage. The LP28303A compares this voltage against its internal V_{NTC1} and V_{NTC2} thresholds to determine if charging is allowed. The temperature sensing circuit is immune to any fluctuation in V_{IN}, since both the external voltage divider and the internal thresholds (V_{NTC1} and V_{NTC2}) are referenced to V_{IN}.

The resistor values of R_1 and R_2 are calculated by the following equations:

For NTC Thermistors:

$$R_1 = \frac{R_{TL}R_{TH}(K_2 - K_1)}{(R_{TL} - R_{TH})K_1K_2}$$

$$R_2 = \frac{R_{TL}R_{TH}(K_2 - K_1)}{R_{TL}(K_1 - K_1K_2) - R_{TH}(K_2 - K_1K_2)}$$

For PTC Thermistors:

$$R_1 = \frac{R_{TL}R_{TH}(K_2 - K_1)}{(R_{TH} - R_{TL})K_1K_2}$$

$$R_2 = \frac{R_{TL}R_{TH}(K_2 - K_1)}{R_{TH}(K_1 - K_1K_2) - R_{TL}(K_2 - K_1K_2)}$$

$K_{1(VNTC1)}$=45%, $K_{2(VNTC2)}$=80%.

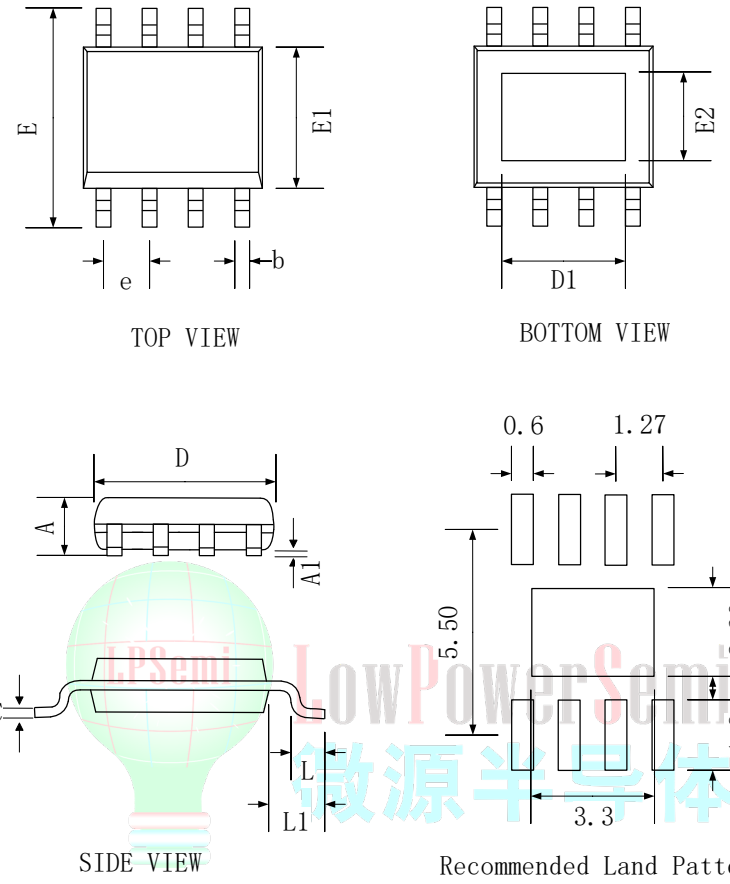
Where R_{TL} is the low temperature resistance and R_{TH} is the high temperature resistance of thermistor, as specified by the thermistor manufacturer. R_1 or R_2 can be omitted if only one temperature (low or high) setting is required. Applying a voltage between the V_{NTC1} and V_{NTC2} thresholds to pin NTC disables the temperature-sensing feature.

Layout Considerations

To minimize radiation, the SW pin and input bypass capacitor leads (between VIN and GND) should be kept as short as possible. A ground plane should be used under the switching circuitry to prevent inter plane coupling. The other paths contain only DC and/or 600KHz tri-wave ripple current and are less critical. With the exception of the input and output filter capacitors (which should be connected to GND) all other components that return to ground should be connected to GND.

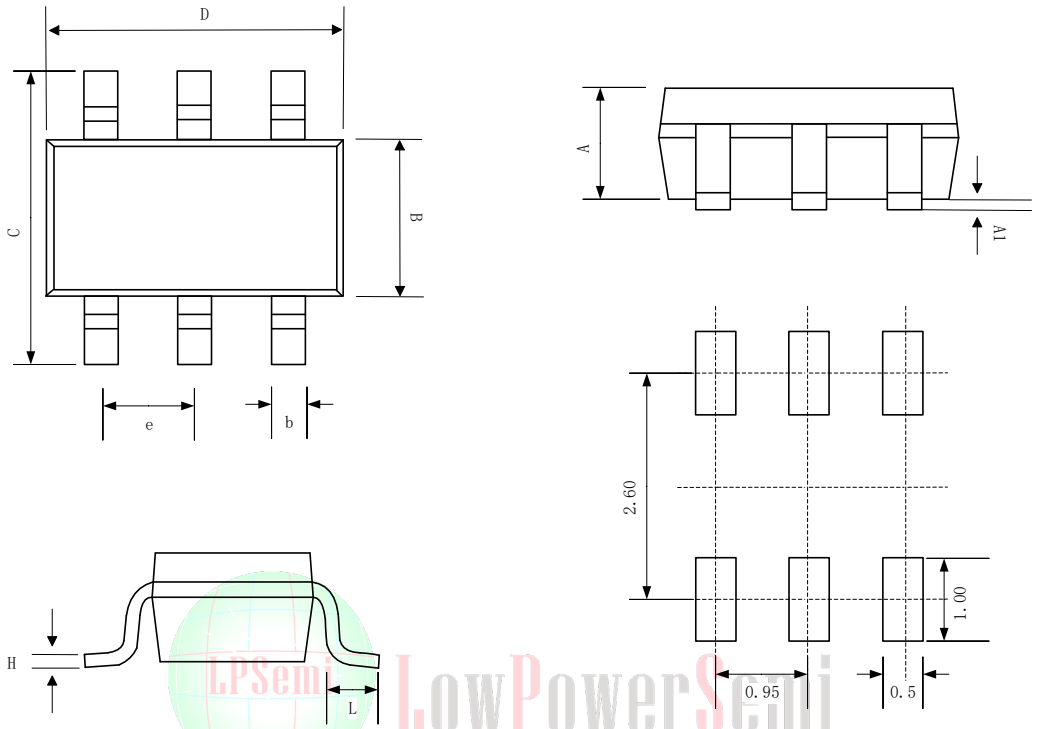
Packaging Information

ESOP8



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	

SOT23-6



Recommended Land Pattern

SYMBOL	MILLIMETER		
	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