

500mA Linear Li-Ion Battery Charger in SOT23



General Description

The FP8101 is a standalone linear Li-ion battery charger with exposed pad SOT23 package. With few external components, FP8101 is well suited for a wide range of portable applications. Charging current can be programmed by an external resistor. In standby mode, supply current will be reduced to around 55uA. Other features include UVLO, automatic recharge, charge status indicators and thermal regulation.

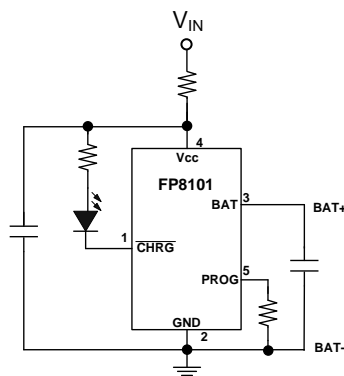
Features

- Standalone Linear Charger for Single Cell Li-ion Batteries
- No External MOSFET, Sense Resistor, or Blocking Diode Required
- Up to 0.5A Programmable Charge Current
- Preset Charge Voltage with $\pm 1\%$ Accuracy
- Automatic Recharge
- 2.9V Trickle Charge Voltage
- C/10 Charge Termination
- 55uA Standby Supply Current
- Charge Status Indicators for No Battery and Charge Failure Display
- Soft-Start to Limit Inrush Current
- Thermal Protection

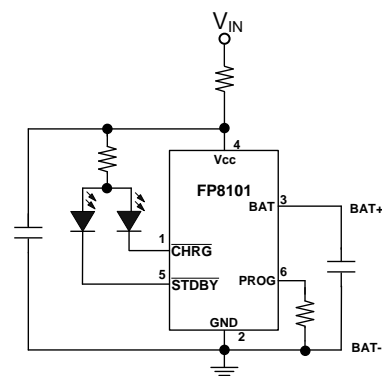
Applications

- Portable Information Appliances
- Charging Docks & Cradles
- Cellular Phones & PDAs
- Handheld Computers

Typical Application Circuit



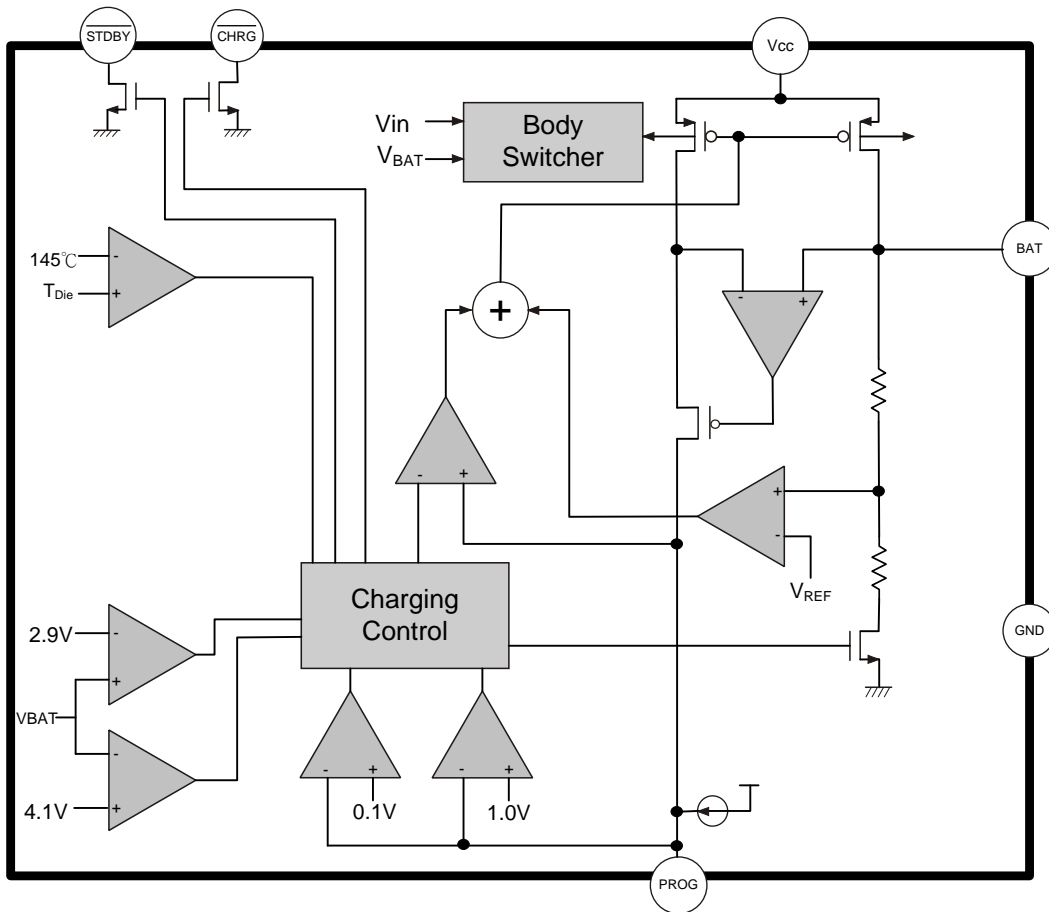
SOT23-5L



SOT23-6L

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Function Block Diagram

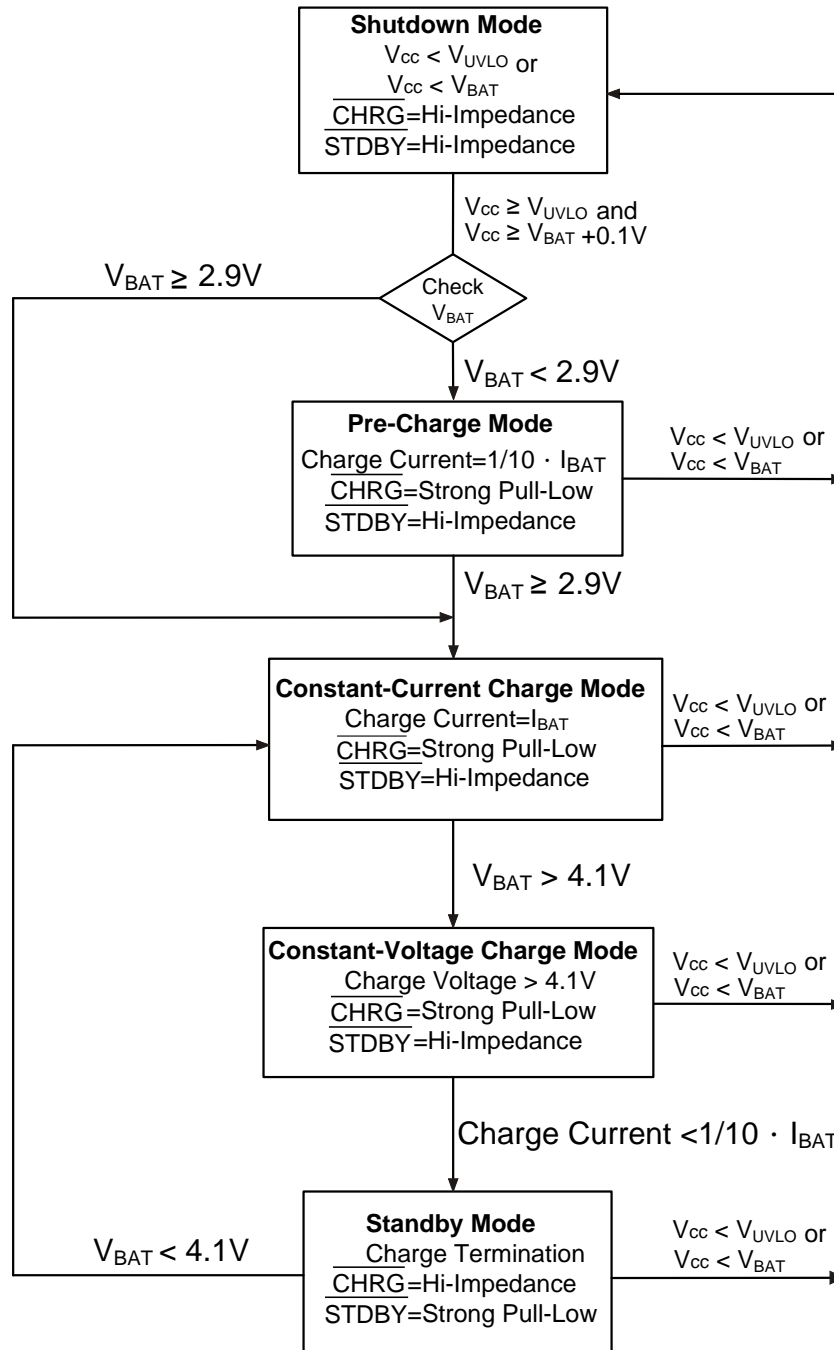


Charge Status Indicators

Charge Status	CHRG (Red)	STDBY (Green)
In Charging	ON	OFF
Charge Termination	OFF	ON
Vcc UVLO	OFF	OFF
NoBat	OFF	ON

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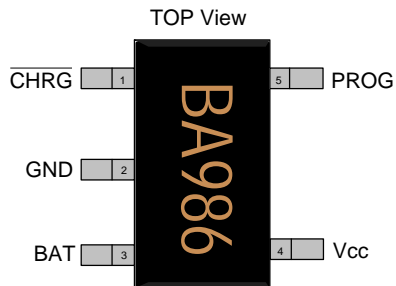
State Diagram



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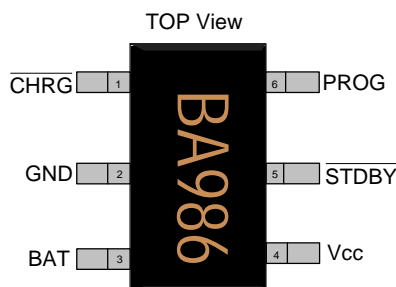
Pin Descriptions

SOT23-5L



Name	No.	I / O	Description
$\overline{\text{CHRG}}$	1	O	Charge State Indicator1
GND	2	P	IC Ground
BAT	3	P	Battery Voltage
V _{CC}	4	P	Supply Voltage
PROG	5	I	CC Charge Current Setting & Monitor

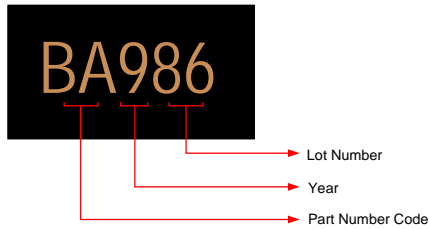
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Name	No.	I / O	Description
$\overline{\text{CHRG}}$	1	O	Charge State Indicator1
GND	2	P	IC Ground
BAT	3	P	Battery Voltage
V _{CC}	4	P	Supply Voltage
$\overline{\text{STDBY}}$	5	O	Charge State Indicator2
PROG	6	I	CC Charge Current Setting & Monitor

Marking Information

SOT23-5L



Halogen Free: Halogen free product indicator

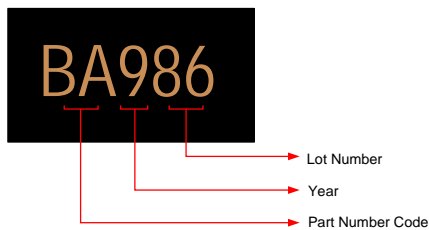
Lot Number: Wafer lot number's last two digits

For Example: 132386TB → 86

Part Number Code: Part number identification code for this product. It should be always "ZY".

Year: Production year's last digit

SOT23-6L



Halogen Free: Halogen free product indicator

Lot Number: Wafer lot number's last two digits

For Example: 132386TB → 86

Part Number Code: Part number identification code for this product. It should be always "ZY".

Year: Production year's last digit

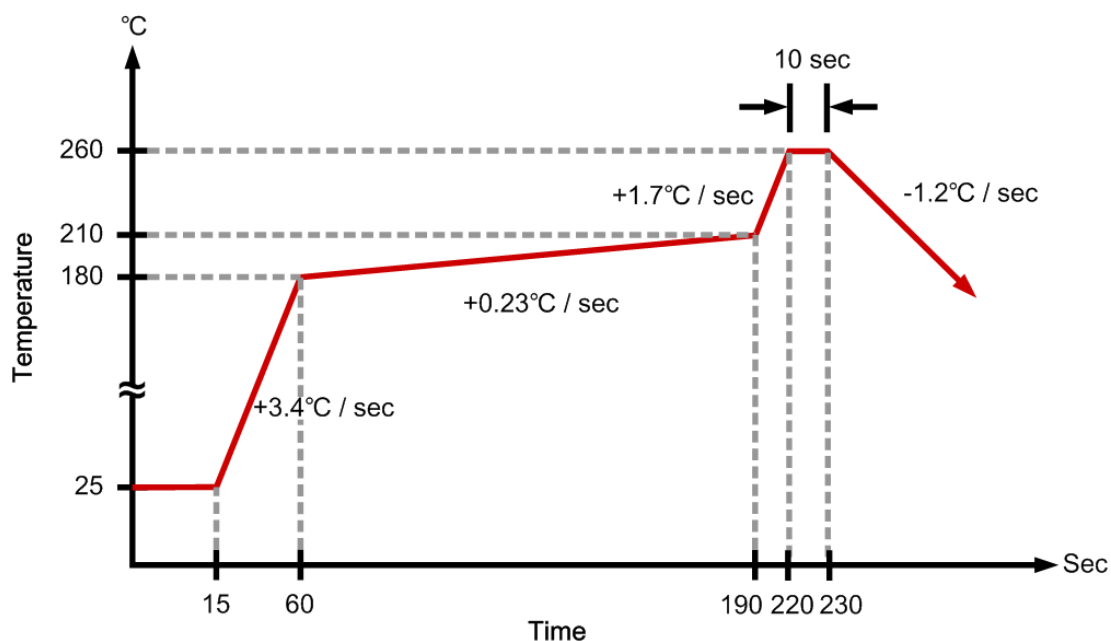
Ordering Information

Part Number	Operating Temperature	Package	MOQ	Description
FP8101KR-G1	-40°C ~ +85°C	SOT23-5L	3000EA	Tape & Reel
FP8101LR-G1	-40°C ~ +85°C	SOT23-6L	3000EA	Tape & Reel

Absolute Maximum Ratings

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	V_{cc}		-0.3		6	V
All Other Pins			-0.3		6	V
BAT Pin Current	I_{BAT}				0.6	A
PROG Pin Current	I_{PROG}				1.2	mA
Junction Temperature	T_J				+150	°C
Storage Temperature	T_S		-65		+150	°C
Thermal Resistance	θ_{JA}	SOT23-5L / SOT23-6L			220	°C / W
	θ_{JC}				110	°C / W
Operating Temperature			-40		+85	°C
Lead Temperature (Soldering, 10 Sec)					+260	°C

Suggested IR Re-flow Soldering Curve



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Recommended Operating Conditions

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	V_{CC}		4.35		5.5	V
Operating Temperature		Ambient Temperature	-40		85	°C

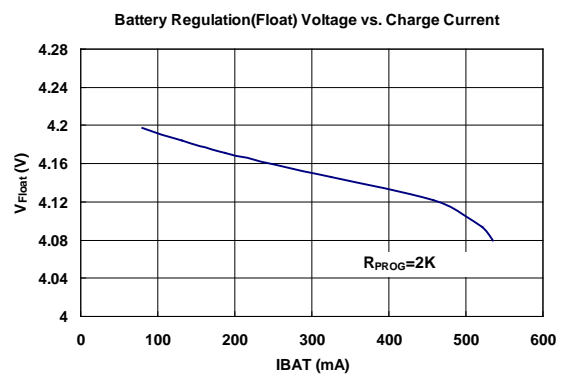
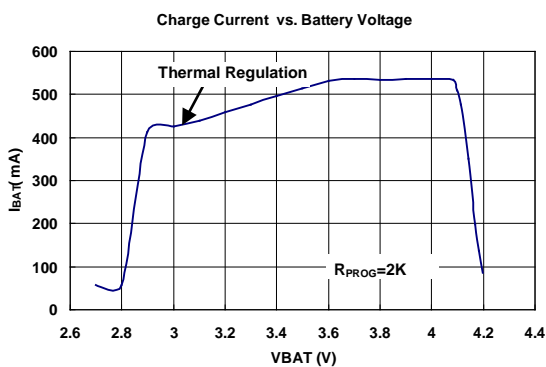
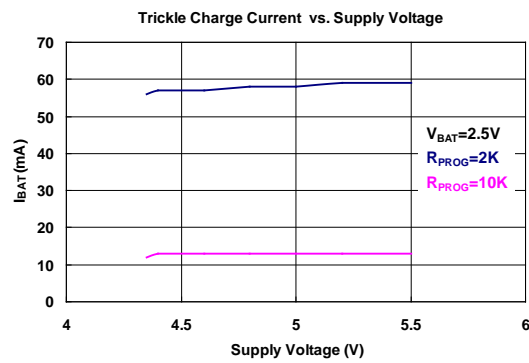
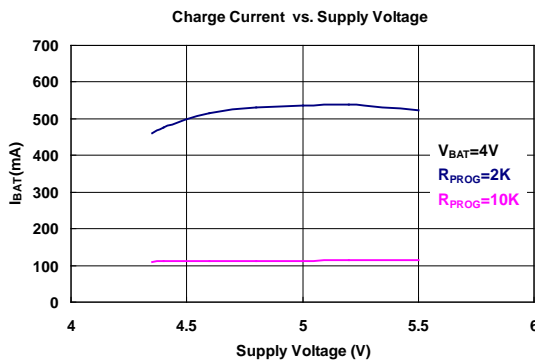
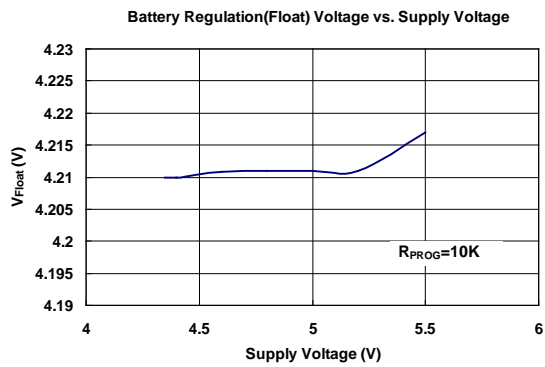
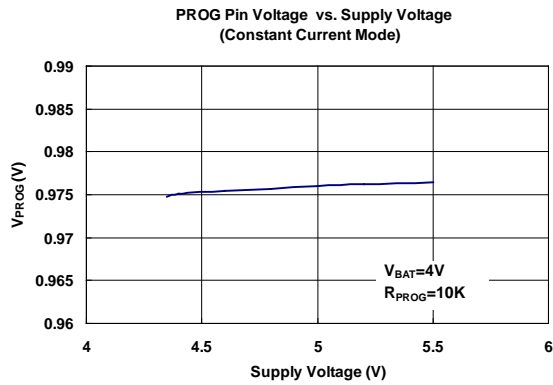
DC Electrical Characteristics ($V_{CC}=5V$, $T_A=25^{\circ}C$, unless otherwise noted)

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Standby Current	I_{SB}	Charge Termination		55	100	μA
Shutdown Supply Current	I_{ST}	$V_{CC} < V_{BAT}$, $V_{CC} < V_{UVLO}$ R_{PROG} not connect		35	60	μA
CV Output (Float) Voltage	V_{FLOAT}	$0^{\circ}C < T_A < 85^{\circ}C$	4.158	4.2	4.242	V
BAT Pin Current	I_{BAT}	$R_{PROG}=2K$	400	500	600	mA
		Standby-Mode, $V_{BAT}=4.2V$	0	-2.5	-6	μA
		Shutdown-Mode,		± 1	± 2	μA
		Sleep-Mode, $V_{CC}=0V$		-1	-2	μA
Trickle Charge Current	I_{TRIKL}	$V_{BAT} < V_{TRIKL}$, $R_{PROG}=2K$		50		mA
Trickle Charge Threshold Voltage	V_{TRIKL}	$R_{PROG}=2K$, V_{BAT} Rising		2.9		V
Trickle Charge Hysteresis Voltage	V_{TRKHYS}	$R_{PROG}=2K$		200		mV
V_{CC} Under Voltage Lockout Threshold	V_{UV}	V_{CC} Rising	3.5	3.7	3.9	V
V_{CC} Under Voltage Lockout Threshold Hysteresis	V_{UVHYS}			500		mV
$V_{CC}-V_{BAT}$ Lockout Threshold	V_{ASD}	V_{CC} Rising		100		mV
		V_{CC} Falling		10		mV
C/10 Termination Current Threshold	I_{TERM}	$R_{PROG}=2K$		50		mA
PROG Pin Voltage	V_{PROG}	$R_{PROG}=2K$, Current Mode	0.9	1.0	1.1	V
CHRGB Pin Output Low Voltage	V_{CHRG}	$I_{CHRG}=5mA$		0.35	0.6	V
STDBYB Pin Output Low Voltage	V_{STDBY}	$I_{STDBY}=5mA$		0.35	0.6	V
Battery Recharge Threshold Voltage	V_{RECHRG}	$V_{FLOAT}-V_{RECHRG}$		150		mV
Temperature Limiting	T_{LIM}			145		°C
Soft-Start Time	T_{SS}	$I_{BAT}=0$ to $I_{BAT}=1000V/R_{PROG}$		20		μs
Recharge Comparator Filter Time	T_{RECHRG}	V_{BAT} High to Low		1.8		mS
C/10 Termination Comparator Filter Time	T_{TERM}	I_{BAT} Falling below I_{TERM}		1.8		mS
PROG Pin Pull-up Current	I_{PROG}			2		μA

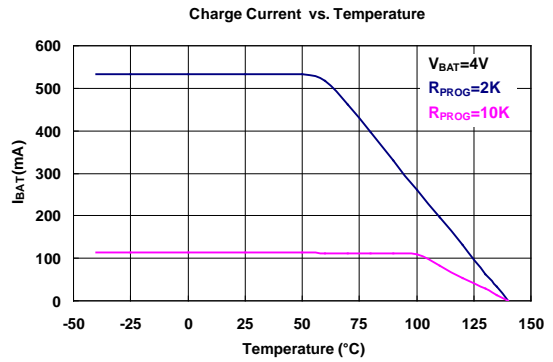
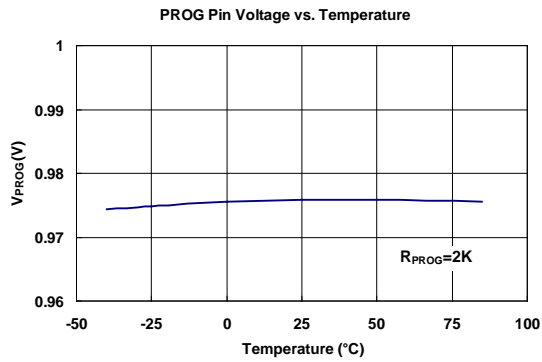
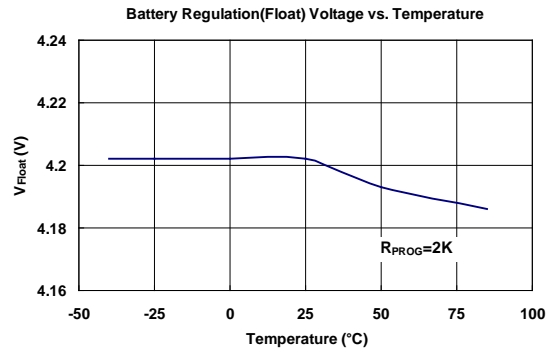
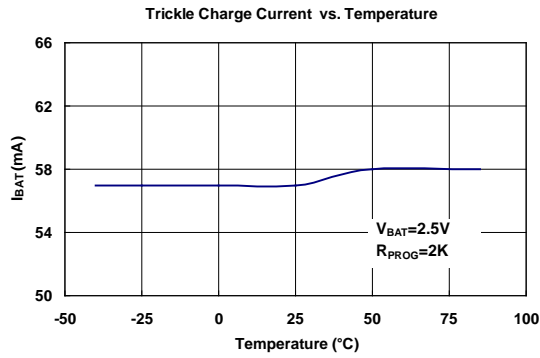
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Typical Operating Characteristics

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



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Function Description

Operation

The FP8101 is a linear battery charger designed primarily for charging single cell lithium-ion batteries. The charger uses a constant-current/constant-voltage charging algorithm with programmable current. Charging current can be programmed by an external single resistor. The FP8101 includes an internal P-channel power MOSFET and thermal regulation circuitry. No blocking diode or external sense resistor are required. Thus, the basic charger circuit requires only two external components. Furthermore, The FP8101 is capable of operating from a USB power source.

Normal Charge Cycle

A charge cycle begins when the voltage at the V_{cc} pin rises above the UVLO threshold. If the BAT pin voltage is smaller than 2.9V, the charger enter trickle charge mode. In this mode, the FP8101 supplies approximately 1/10 the programmed charging 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 full programmed charge current is supplied to the battery. When the BAT pin approaches the float voltage (4.1V), the FP8101 enters the 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 by a single resistor connected from the PROG pin to ground. The battery charging current is 1000 times the current flowing out of the PROG pin. The required resistor value can be calculated from the charge current with following equation:

$$R_{PROG} = \frac{1000}{I_{CHG(MAX)}}$$

The instantaneous charging current may differ from above equation in trickle or constant voltage modes. The instantaneous charging current provided to the battery can be determined by monitoring the PROG pin voltage at any time with the following equation:

$$I_{CHG} = \frac{V_{PROG}}{R_{PROG}} \times 1000$$

Charge Termination

A charge cycle is terminated when the charge current falls to 1/10 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 T_{TERM} (1.8ms), charging is terminated. The charge current is shut off and the FP8101 enters standby mode, where the input supply current drops to 55uA. The FP8101 draws no current from the battery in standby mode. This feature reduces the charge and discharge cycles on the battery, further prolong the battery life.

Thermal Protection

An internal thermal feedback loop reduces the programmed charge current if the die temperature rises above a preset value of approximately 145°C. This feature protects the FP8101 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 FP8101. The charge current can be set according to typical ambient temperature with the assurance that the charge will automatically reduce the current in worst case condition.

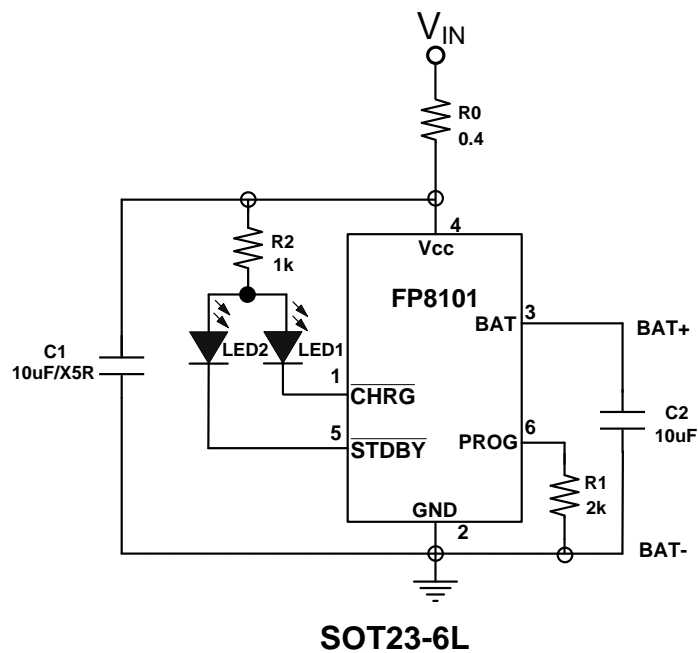
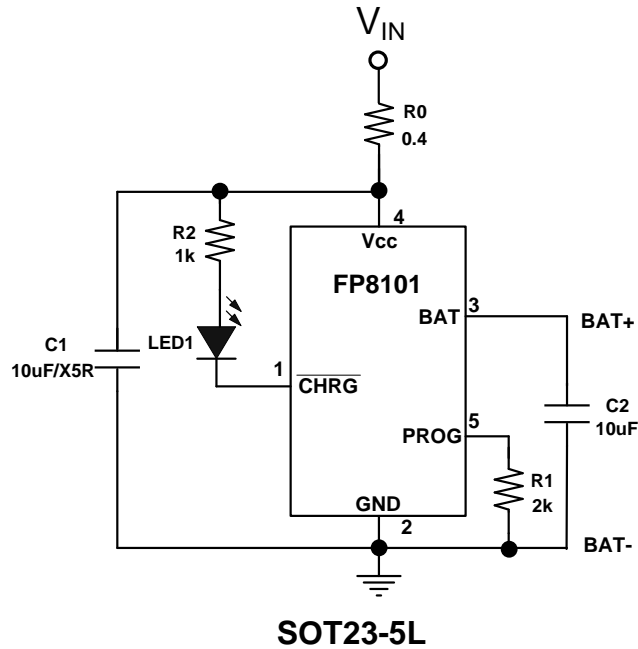
Under Voltage Lockout (UVLO)

An internal under voltage lockout circuit monitors the input voltage and keeps the charger in shutdown mode until V_{CC} rises above the under voltage lockout threshold. The UVLO circuit has a built-in hysteresis of 500mV. Furthermore, to protect against reverse current in the power MOSFET, the UVLO circuit force FP8101 to enter shutdown mode if V_{CC} falls to within 10mV of the battery voltage. If the UVLO comparator is tripped, the charger will not come out of shutdown mode until V_{CC} rises 100mV above the battery voltage.

Automatic Recharge

Once the charge cycle is terminated, the FP8101 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 4.1V (which corresponds to approximately 80% to 90% battery capacity). This ensures that the battery is kept at or near a fully charged condition and eliminated the need for periodic charge cycle initiations. \overline{CHRG} output enters a strong pull-down state during recharge cycles.

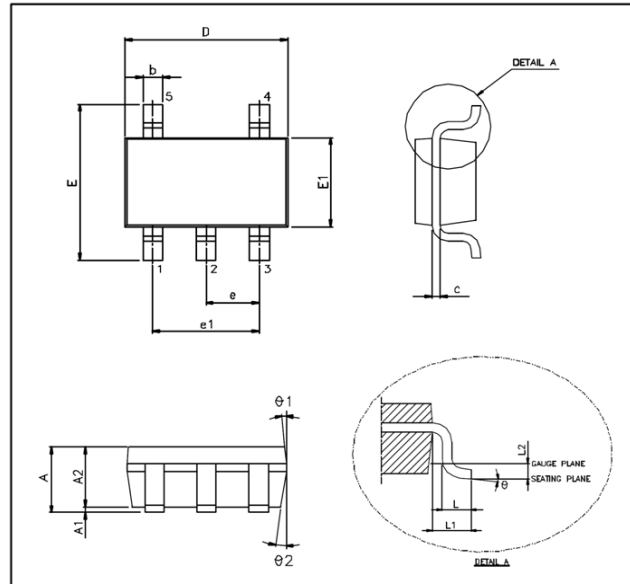
Typical Application



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Package Outline

SOT23-5L

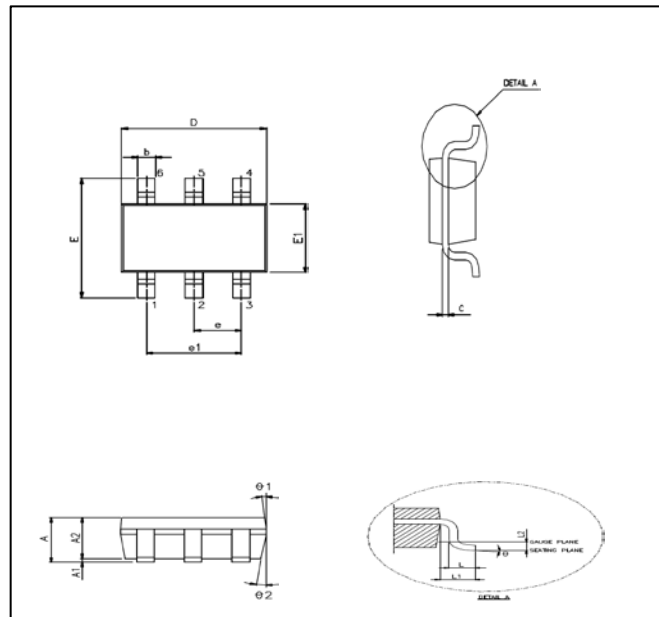


Symbols	Min. (mm)	Max.(mm)
A	1.050	1.350
A1	0.050	0.150
A2	1.000	1.200
b	0.250	0.500
c	0.080	0.200
D	2.700	3.000
E	2.600	3.000
E1	1.500	1.700
e	0.950 BSC	
e1	1.900 BSC	
L	0.300	0.550
L1	0.600 REF	
L2	0.250 BSC	
θ°	0°	10°
$\theta1^\circ$	3°	7°
$\theta2^\circ$	6°	10°

Note:

1. Package dimensions are in compliance with JEDEC outline: MO-178 AB.
2. Dimension “D” does not include molding flash, protrusions or gate burrs.
3. Dimension “E1” does not include inter-lead flash or protrusions.

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Unit: mm

Symbols	Min. (mm)	Max. (mm)
A	1.050	1.450
A1	0.050	0.150
A2	0.900	1.300
b	0.300	0.500
c	0.080	0.220
D	2.900 BSC	
E	2.800 BSC	
E1	1.600 BSC	
e	0.950 BSC	
e1	1.900 BSC	
L	0.300	0.600
L1	0.600 REF	
L2	0.250 BSC	
θ°	0°	8°
θ1°	3°	7°
θ2°	6°	15°

Note:

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2. Dimension "D" does not include molding flash, protrusions or gate burrs.
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