2A Switch-Mode Li-Ion Battery Charger

General Description

The FP8202 is a highly integrated switch-mode Li-Ion Battery Charger. With few external components, FP8202 is well suited for a wide range of portable applications. Charging current can be programmed by an external current sensing resistor. With 600KHz switching frequency, FP8202 can use of small external components. Other features include UVLO, automatic recharge, charge status indicators and battery temperature monitor.

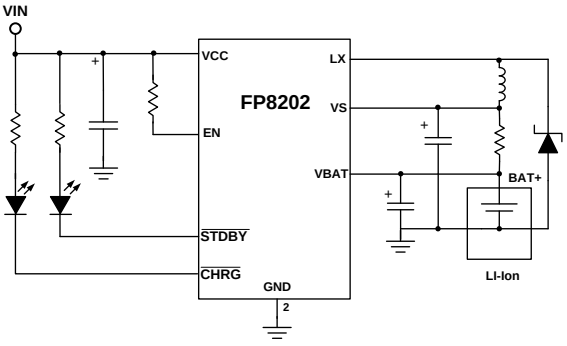
Features

- Up to 2A Programmable Charge Current
- No external MOSFET, Sense Resistor, or Blocking Diode Required
- Switch-model Charger for single cell Li-Ion Batteries
- Preset Charge Voltage with ±1% Accuracy
- Automatic Recharge
- 2.9V Trickle Charge Voltage
- C/10 Charge Termination
- Thermal Protection
- Charge Status Indicators for No Battery and Charge Failure Display

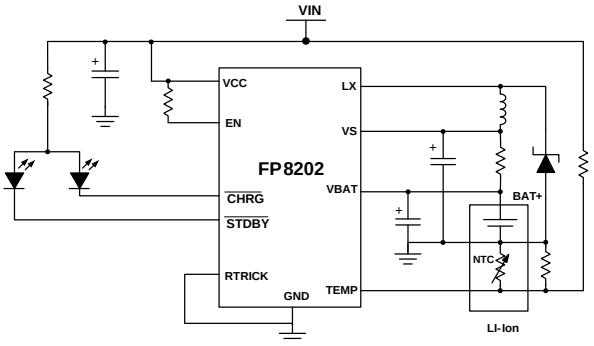
Applications

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

Typical Application Circuit



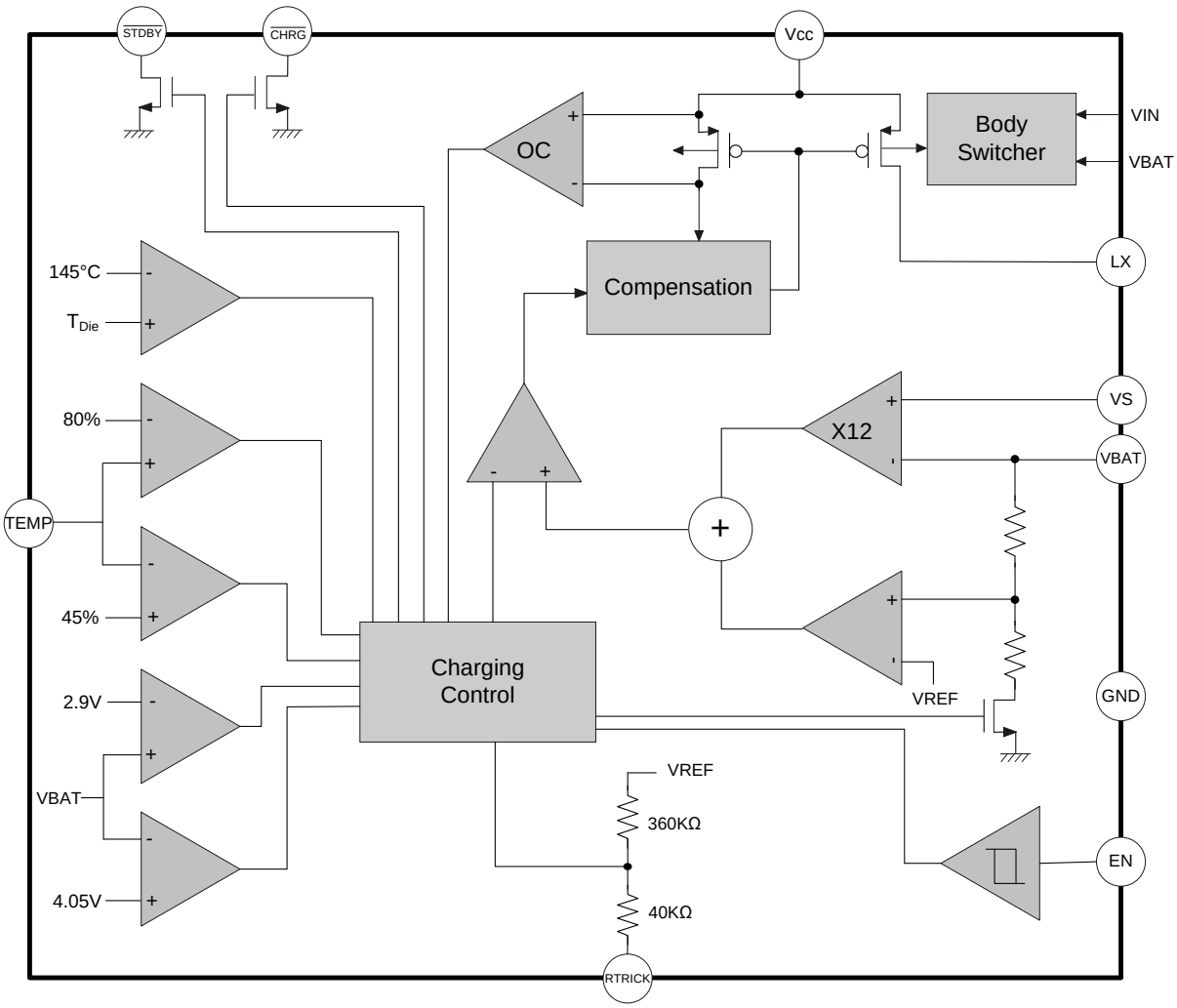
SOP-8L (EP)



DFN-10L (EP)

This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.

Function Block Diagram

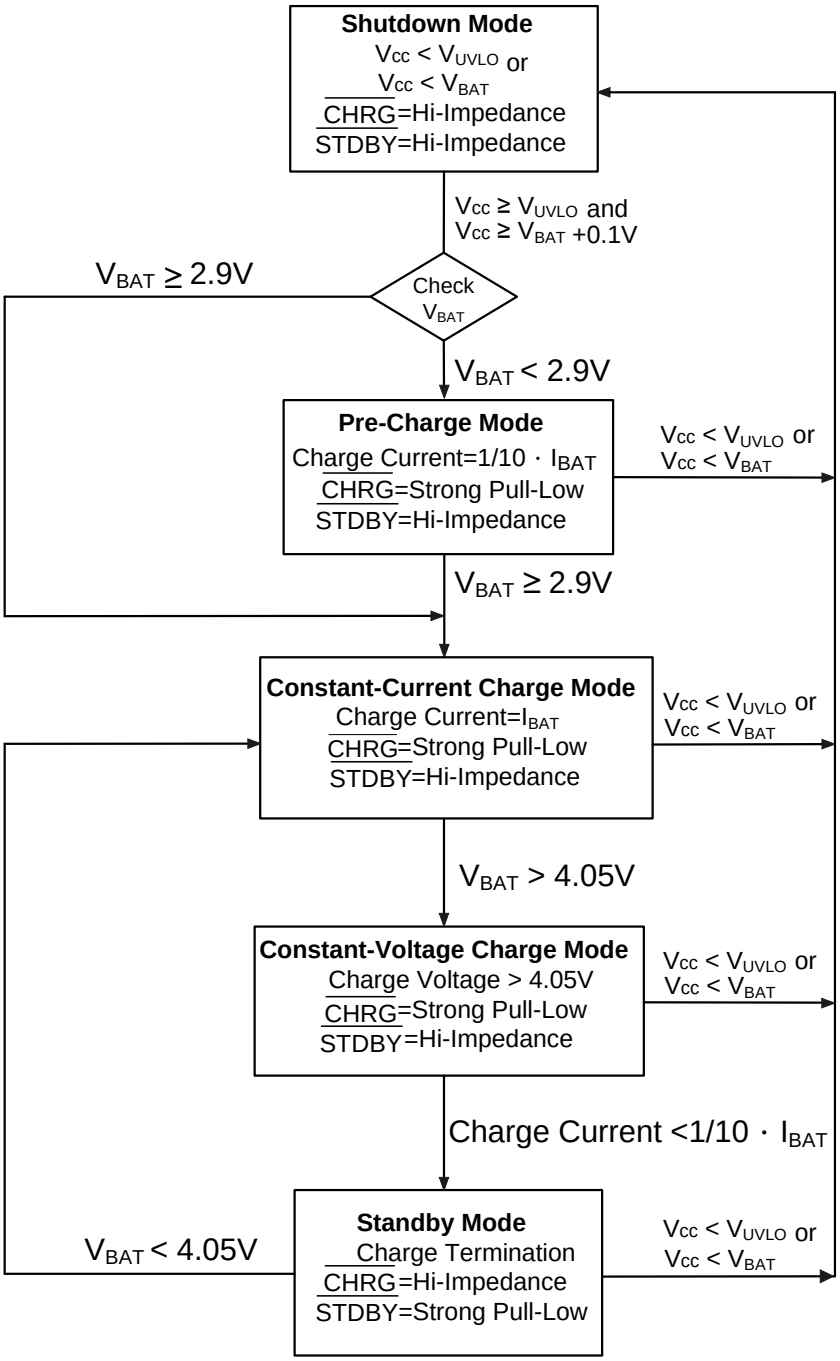


Charge Status Indicators

Charge Status	$\overline{\text{CHRG}}$ (Red)	$\overline{\text{STDBY}}$ (Green)
In Charging	ON	OFF
Charge Termination	OFF	ON
UVLO, OverT, UnderT, NoBat(with TEMP used)	OFF	OFF

This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.

State Diagram



This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.

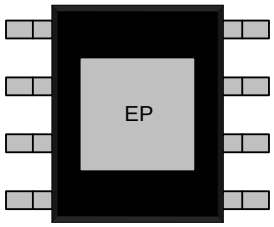
Pin Descriptions

SOP-8L (EP)

TOP View



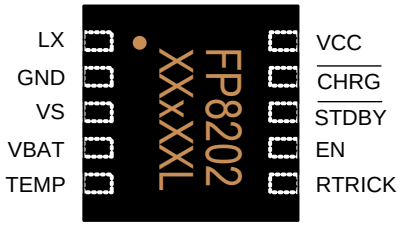
Bottom View



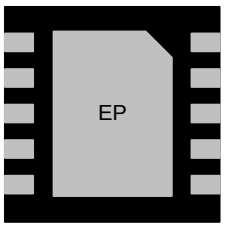
Name	No.	I / O	Description
LX	1	I	Switch node and inductor connection pin
GND	2	P	IC Ground
VS	3	I	Charge current-sense input
VBAT	4	P	Battery Voltage
EN	5	I	Enable Control
$\overline{\text{STDBY}}$	6	O	Charge State Indicator2
$\overline{\text{CHRG}}$	7	O	Charge State Indicator1
VCC	8	P	Supply Voltage
EP	9	P	Exposed PAD-Must connect to Ground

DFN-10L (EP)

Top View



Bottom View

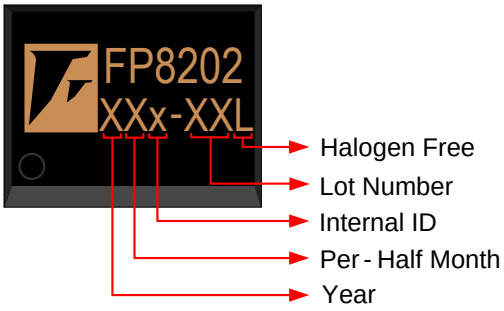


Name	No.	I / O	Description
LX	1	I	Switch node and inductor connection pin
GND	2	P	IC Ground
VS	3	I	Charge current-sense input
VBAT	4	P	Battery Voltage
TEMP	5	I	Battery Temperature Detector
RTRICK	6	I	CC Charge Current Setting & Monitor
EN	7	I	Enable Control
$\overline{\text{STDBY}}$	8	O	Charge State Indicator2
$\overline{\text{CHRG}}$	9	O	Charge State Indicator1
VCC	10	P	Supply Voltage
EP	11	P	Exposed PAD-Must connect to Ground

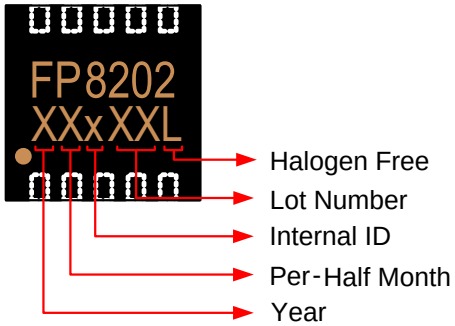
This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.

Marking Information

SOP-8L (EP)



DFN-10L (EP)



Halogen Free: Halogen free product indicator

Lot Number: Wafer lot number's last two digits

For Example → Lot : 123456 → XXx-56L

Internal ID: Internal Identification Code

Per-Half Month: Production period indicator in half month time unit

For Example : A → First Half Month of January
B → Second Half Month of January
C → First Half Month of February
D → Second Half Month of February

Year: Production year's last digit

This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.

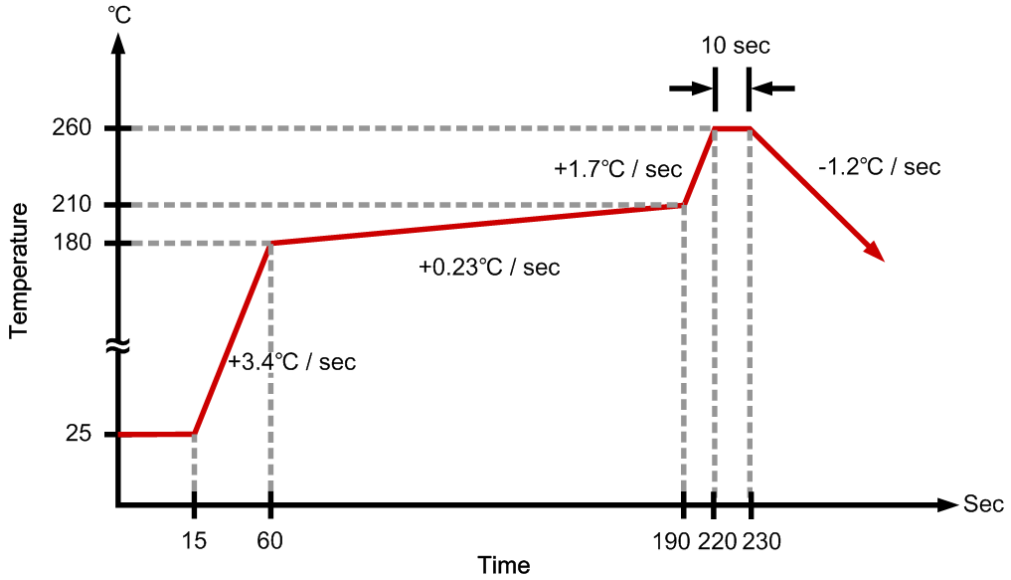
Ordering Information

Part Number	Operating Temperature	Package	MOQ	Description
FP8202XR-G1	-40°C ~ +85°C	SOP-8L(EP)	2500EA	Tape & Reel
FP8202dR-G1	-40°C ~ +85°C	DFN-10(EP)	2500EA	Tape & Reel

Absolute Maximum Ratings

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	Vcc		-0.3		6	V
LX to VCC Voltage	V_{DS}				-7	V
All Other Pins			-0.3		6	V
BAT pin Current	I_{BAT}				2.5	A
Junction Temperature	T_J				+150	°C
Storage Temperature	T_S		-65		+150	°C
Thermal Resistance (Junction to Ambient)	θ_{JA}	DFN-10L			65	°C / W
		SOP-8L			50	°C / W
Thermal Resistance (Junction to Case)	θ_{JC}	DFN-10L			10	°C / W
		SOP-8L			10	°C / W
Operating Temperature			-40		+85	°C
Lead Temperature (soldering, 10 sec)					+260	°C

Suggested IR Re-flow Soldering Curve



This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.

Recommended Operating Conditions

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

DC Electrical Characteristics (V_{cc}=5V, T_A= 25°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		55	100	μA
CV Output (Float) Voltage	V_{FLOAT}	0℃<T_A<85℃	4.158	4.200	4.242	V
BAT pin Current	I_{BAT}	R_{Sense}=0.05Ω	1800	2000	2200	mA
		R_{Sense} =0.1Ω	900	1000	1100	mA
		R_{Sense} =0.2Ω	450	500	550	mA
		Standby-Mode, V_{BAT}=4.2V	0	-2.5	-6	μA
		Shutdown-Mode,		±4	±6	μA
		Sleep-Mode, V_{CC}=0V		-4	-6	μA
Trickle Charge Current	I_{TRIKL}	$V_{BAT} < V_{TRIKL}$, R_{Sense}=0.05Ω		200		mA
Trickle Charge Threshold Voltage	V_{TRIKL}	R_{Sense} =0.1Ω, V_{BAT} Rising	2.8	2.9	3.0	V
Trickle Charge Hysteresis Voltage	V_{TRKHYS}	R_{Sense} =0.1Ω		200		mV
V_{CC} Under Voltage Lockout Threshold	V_{UV}	Vcc 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		250		mV
		V_{cc} Falling		100		mV
PMOSFET On Resistance	R_{ON}			260		mΩ
C/10 Termination Current Threshold	I_{TERM}	R_{Sense} =0.1Ω		100		mA
		R_{Sense}=0.05Ω		200		mA
Switching Frequency	Fsw		500	600	700	KHz
Max. Duty	D_{MAX}			100		%
Min. Duty	D_{MIN}		0			%
CHRGB pin Output Low Voltage	V_{CHRG}	I_{CHRG}=5mA		0.3	0.6	V
STDBYB pin Output Low Voltage	V_{STDBY}	I_{STDBY}=5mA		0.3	0.6	V
Battery Recharge Threshold Voltage	V_{RECHRG}	V_{FLOAT}-V_{RECHRG}		150		mV
Thermal Shutdown	T_{LIM}			145		°C
TEMP pin High Threshold Voltage	V_{TEMP-H}			80		%
TEMP pin Low Threshold Voltage	V_{TEMP-L}			45		%
Soft-Start Time	T_{SS}	I_{BAT}=0 to I_{BAT}=0.1V/R_S		20		μs
Recharge Comparator Filter Time	T_{RECHRG}	V_{BAT} High to Low	0.8	1.8	4	mS
C/10Termination Comparator Filter Time	T_{TERM}	I_{BAT} Falling below I_{TERM}	0.8	1.8	4	mS

This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.

Function Description

Operation

The FP8202 is a switch-mode battery charger designed primarily for charging single cell lithium-ion batteries. The charger uses a constant-current/constant-voltage charge algorithm with programmable current. Charging current can be programmed externally with a single current sensing resistor between the VS pin and the BAT pin. The final battery float voltage is internally set to 4.2V.

Normal Charge Cycle

A charge cycle begins when the voltage at the VCC 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 FP8202 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 voltage approaches 4V, the FP8202 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

When the battery voltage exceeds the trickle charge threshold, the charger goes into the full scale constant current charge mode. In constant current mode, the charge current is set by the external sense resistor R_{SENSE} and an internal 100mV reference, The required resistor value can be calculated from the charge current with following equation:

$$R_{sense} = \frac{100mV}{I_{CHG}}$$

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 sense voltage. When the voltage between the VS pin and the BAT pin falls below 10mV for longer then T_{TERM} (1.8ms), charging is terminated. The charge current is latched of and the FP8202 enters standby mode, where the input supply current drops to 55uA. The FP8202 draws no current from the battery in standby mode. This feature reduces the charge and discharge cycles on the battery, further prolonging the battery life.

This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.

Thermal Protection

FP8202 will shutdown automatically when the internal junction temperature reaches 140℃ to protect both the part and the system.

Battery Temperature Fault Monitoring

In the event of a battery over-temperature condition, the charging control will turn off the internal pass device and report a battery temperature fault on the TEMP pin. Inside the FP8202, two internal voltage references V_{TEMP-H} and V_{TEMP-L} are fixed at 80% ×V_{CC} and 45% ×V_{CC} respectively. As the TEMP pin voltage rises above V_{TEMP-H} or falls below V_{TEMP-L}, the FP8202 stops charging and indicates a fault condition. After the system recovers from a temperature fault, the device will resume charging operation. For applications that do not need to monitor the battery temperature, short the TEMP pin to the GND.

The values of R1 and R2 are set according to the battery temperature range and the value of thermal sensitive resistor. If the battery is equipped with NTC(Negative Temperature Coefficient) thermistor and the temperature monitor range is T_L~T_H(T_L< T_H), then R_T, the thermistor resistance, decreases as temperature increases from T_L to T_H, means R_{TL}>R_{TH}.

The TEMP pin voltage can be calculated as:

$$V_{TEMP} = \frac{R2 // R_T}{R1 + R2 // R_T} \times Vcc$$

Thus, this V_{TEMP} decreases as the temperature increase from T_L to T_H.

To set proper R1 and R2 value for temperature protection, we set:

$$0.8 \times Vcc = V_{TEMPH} = \frac{R2 // R_{TL}}{R1 + R2 // R_{TL}} \times Vcc \quad \text{at } T_L$$

$$0.45 \times Vcc = V_{TEMPL} = \frac{R2 // R_{TH}}{R1 + R2 // R_{TH}} \times Vcc \quad \text{at } T_H$$

Where R_{TL} and R_{TH} are the thermistor resistances at T_L and T_H respectively.

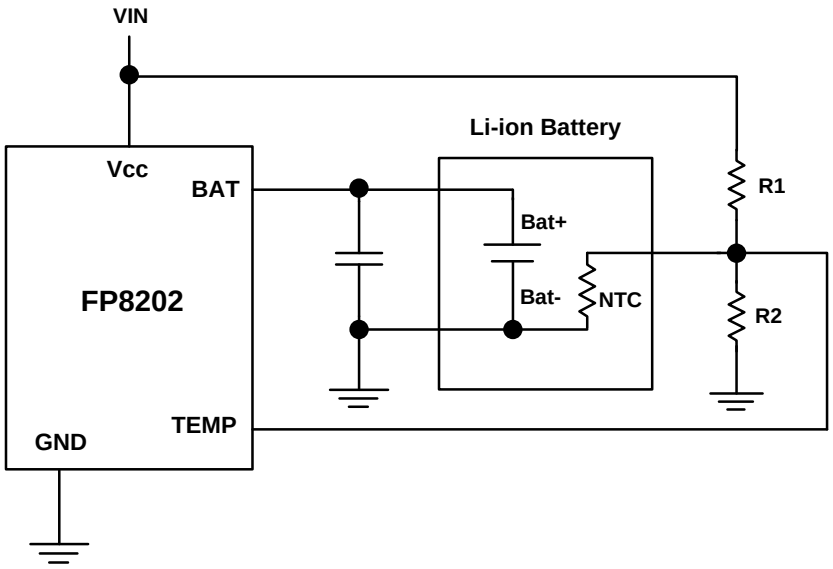
So R1 and R2 can be derived as following:

This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.

$$R1=\frac{R_{TL}R_{TH}(K_2-K_1)}{(R_{TL}-R_{TH})K_1K_2}=\frac{R_{TL}R_{TH}\times 35}{(R_{TL}-R_{TH})\times 36}$$

$$R2=\frac{R_{TL}R_{TH}(K_2-K_1)}{R_{TL}(K_1-K_1K_2)-R_{TH}(K_2-K_1K_2)}=\frac{R_{TL}R_{TH}\times 35}{R_{TL}\times 9-R_{TH}\times 44}$$

where K_1=0.45 and K_2=0.8



Under Voltage Lockout (UVLO)

An internal under voltage lockout circuit monitors the input voltage and keeps the charger in shutdown mode until Vcc 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 keeps the charge in shutdown mode if Vcc falls to within 100mV of the battery voltage, If the UVLO comparator is tripped, the charger will not come out of shutdown mode until Vcc rises 250mV above the battery voltage.

This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.

Manual shutdown

At any point in the charge cycle, the FP8202 can be put into shutdown mode when put the EN pin to the low-level voltage. This reduces the battery drain current to about to 2uA and the supply current to less than 55uA.

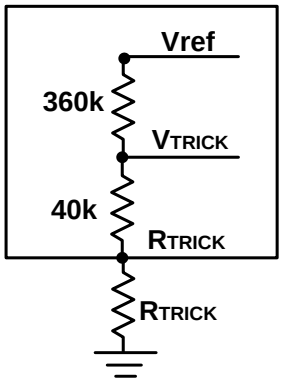
Automatic Recharge

Once the charge cycle is terminated, the FP8202 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 eliminated the need for periodic charge cycle initiations. $\overline{CHRG}$ output enters a strong pull-down state during recharge cycles.

Programming Trickle Charge Current

If the battery voltage is below the trickle charge threshold, the FP8202 delivers a small current to charge the battery until the battery voltage reaches the fast charge threshold value. the trickle charge current is set by the external resistor R_{TRICK}. For applications that do not need to set the trickle charge current, short the R_{TRICK} pin to the GND. The FP8202 supplies approximately 1/10 the programmed charging current to bring the battery voltage up to a safe level. The trickle charge current value can be calculated with following equation:

$$I_{TRICK} = \frac{40k + Rtrick}{400k + Rtrick} \times I_{CHG}$$



This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.

Application Information

Inductor Selection

Inductance value is decided based on different condition. 3.3uH to 4.7μH inductance value is recommended for general application circuit. There are three important inductor specifications, DC resistance, saturation current and core loss. Low DC resistance has better power efficiency.

Capacitor Selection

Use Low ESR capacitors are preferred to reduce the input inrush voltage, Ceramic capacitor of X5R and X7R are recommended, which have low equivalent series resistance (ESR) and wider operation temperature range.

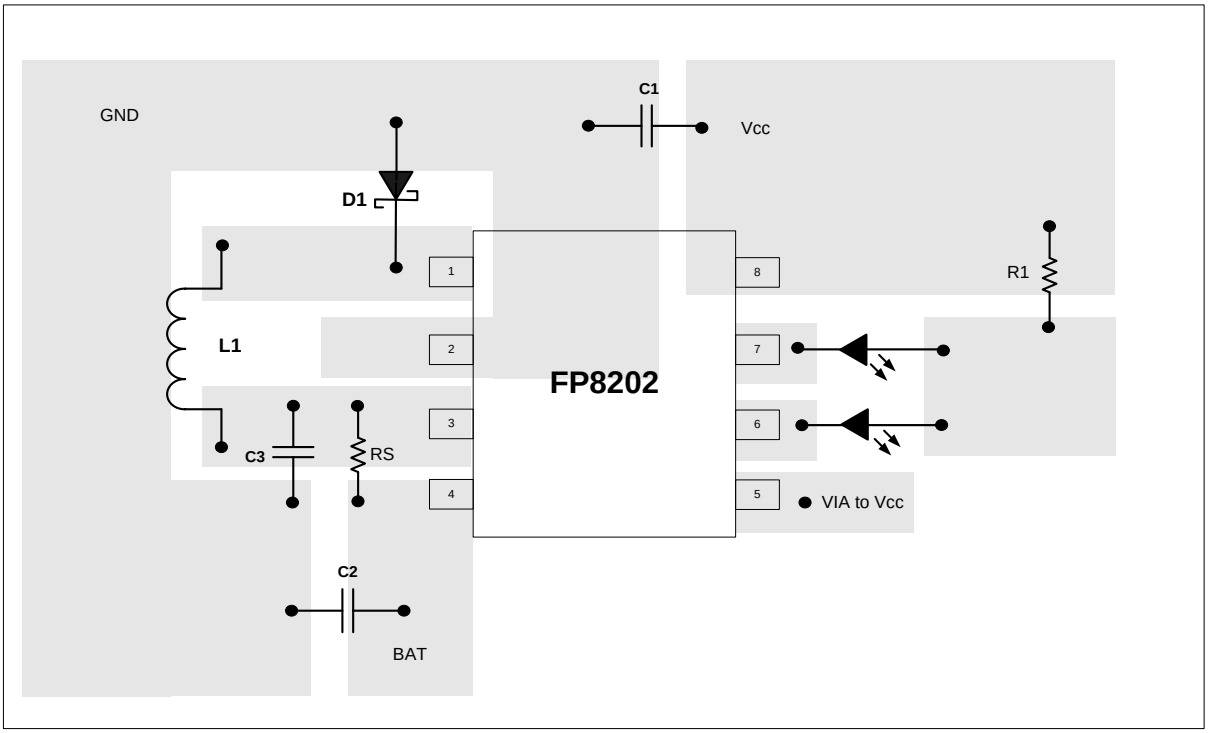
Diode Selection

Schottky diodes with fast recovery times and low forward voltages are recommended. Ensure the diode average and peak current rating exceed the average output current and peak inductor current. In addition, the diode's reverse breakdown voltage must exceed the Vcc voltage.

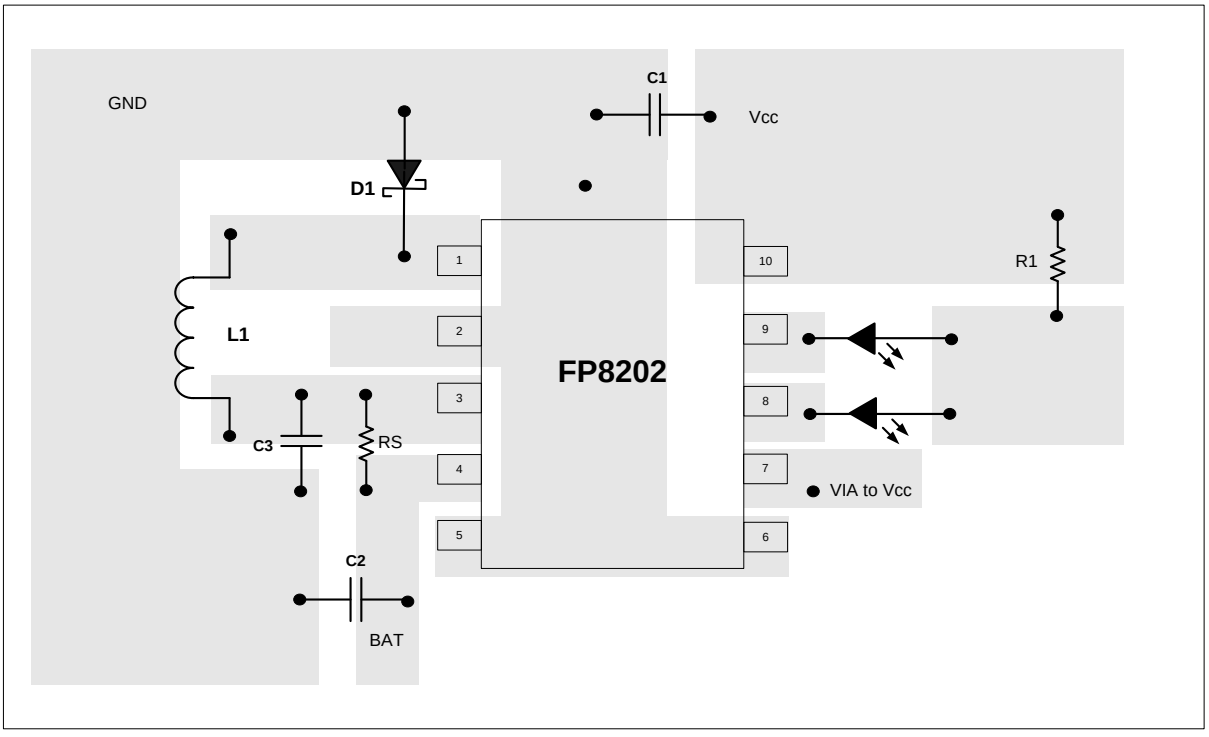
Layout Considerations

1. The power traces, consisting of the GND trace, the LX trace and the battery trace should be kept short,direct and wide.
2. Layout switching node LX, inductor and diode connection traces wide and short to reduce EMI.
3. Place C_{IN} nearby V_{CC} pin as closely as possible to maintain input voltage steady and filter out the pulsing input current.
4. The GND of the C_{IN} and Schottky should be connected close together and directly to a ground plane.
5. Place R_{SENSE} nearby BAT pin and VS pin.

This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.



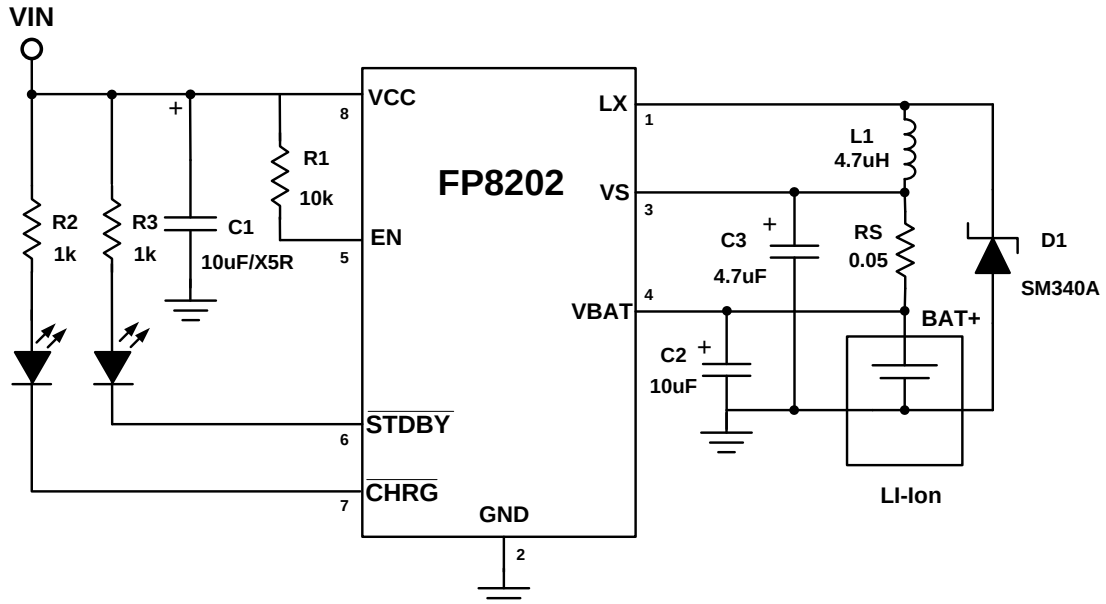
SOP-8L (EP) Suggested Layout



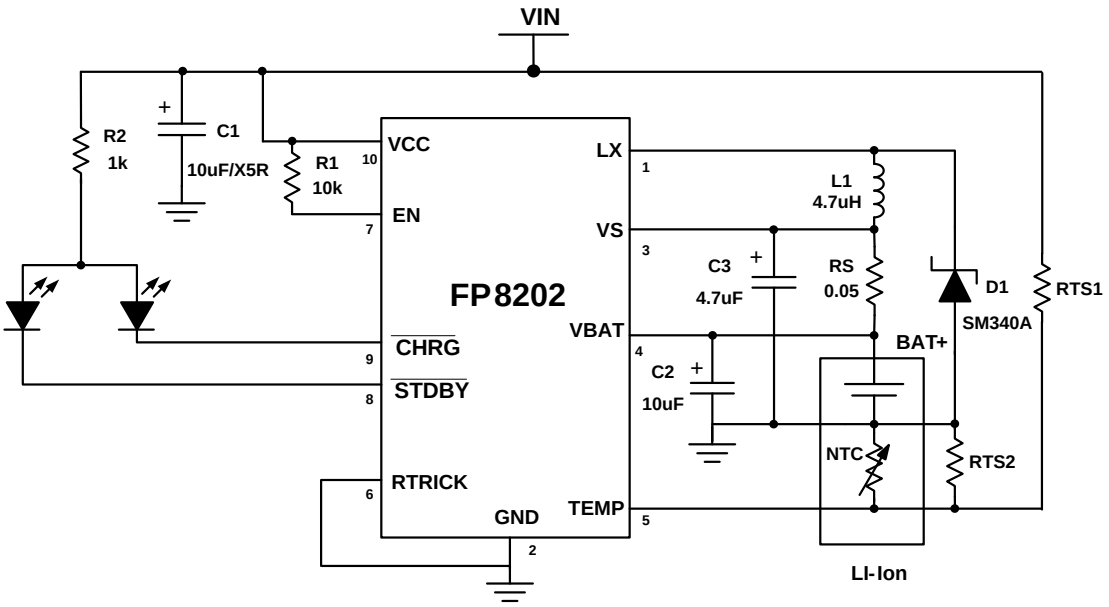
DFN-10L (EP) Suggested Layout

This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.

Typical Application



SOP-8L (EP)

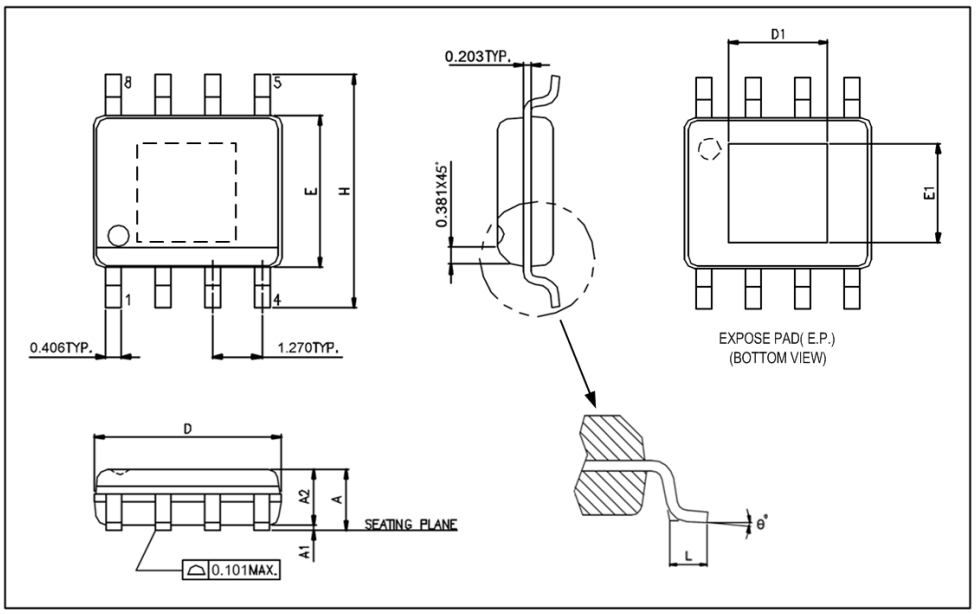


DFN-10L (EP)

This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.

Package Outline

SOP-8L (EP)



Symbols	Min. (mm)	Max. (mm)
A	1.346	1.752
A1	0.050	0.152
A2		1.498
D	4.800	4.978
E	3.810	3.987
H	5.791	6.197
L	0.406	1.270
θ°	0°	8°

UNIT: mm

Exposed PAD Dimensions:

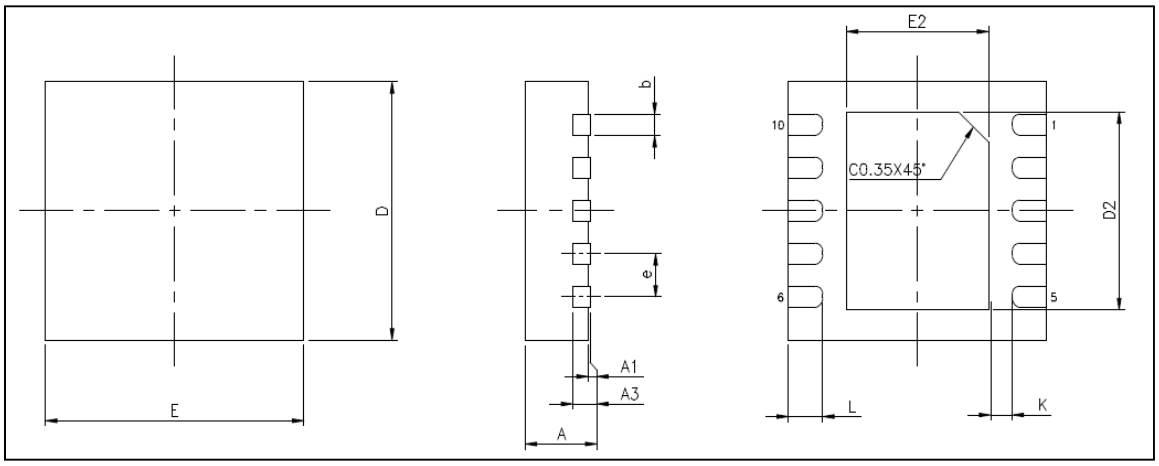
Symbols	Min. (mm)	Max. (mm)
E1	1.94	2.29
D1	1.94	2.29

Note:

1. Package dimensions are in compliance with JEDEC outline: MS-012 AA.
2. Dimension ”D” does not include molding flash, protrusions or gate burrs.
3. Dimension “E” does not include inter-lead flash or protrusions.

This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.

DFN-10L (EP)



Unit: mm

Symbols	Min. (mm)	Max. (mm)
A	0.700	0.800
A1	0.000	0.050
A3	0.20REF	
b	0.180	0.300
D	3.00	
E	3.00	
D2	2.200	2.700
E2	1.400	1.750
e	0.500	
L	0.300	0.500
K	0.200	

Note:

1. JEDEC Outline :N/A
2. Dimensions “D” does not include mold flash, protrusions or gate burrs mold flash
3. Protrusions and gate burrs shall not exceed .15mm (.006in) per side.
   Dimensions “E” does not include inter-lead flash or protrusions inter-lead flash and protrusions
4. Shall not exceed 25mm (.010in) per side.

This datasheet contains new product information. Feeling Technology reserves the rights to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sales of the product.