1.5A, Switch Mode Li-Lon Battery Charger

Description

The SC61B15 is a complete switching battery charger for one (4.2V) cell lithium-ion battery. The SC61B15 provides a small, simple and efficient solution to fast charge Li-ion battery. An external sense resistor sets the charge current with high accuracy.

The maximum charge current which programmed by a resistor is up to 1.2A. An internal resistor divider and precision reference set the final float voltage to 4.2V. When the input supply is removed, the SC61B15 automatically enters a low current sleep mode.

The SC61B15 is available in the 10-Lead DFN package.

Features

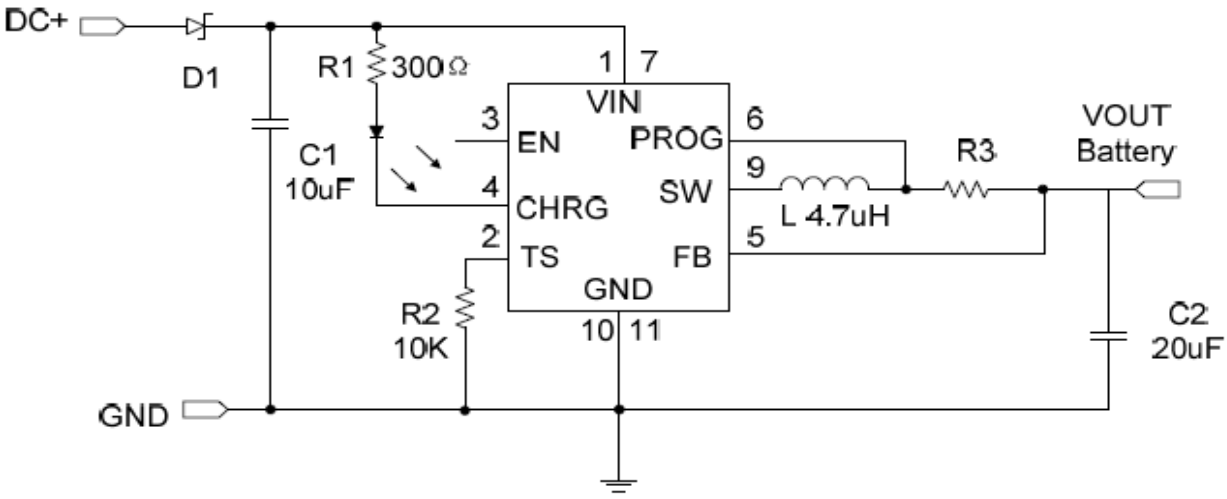
- **Input Voltage Range: 4.7V-5V**
- **End - Charge - Current Detection Output**
- **Constant Switching Frequency for Minimum Noise**
- **Automatic Battery Recharge**
- **Automatic Shutdown When Input Supply is Removed**
- **Automatic Trickle Charging of Low Voltage Batteries**
- **Battery Temperature Sensing**
- **Stable with Ceramic Output Capacitor**
- **10-Lead DFN Package**

Application

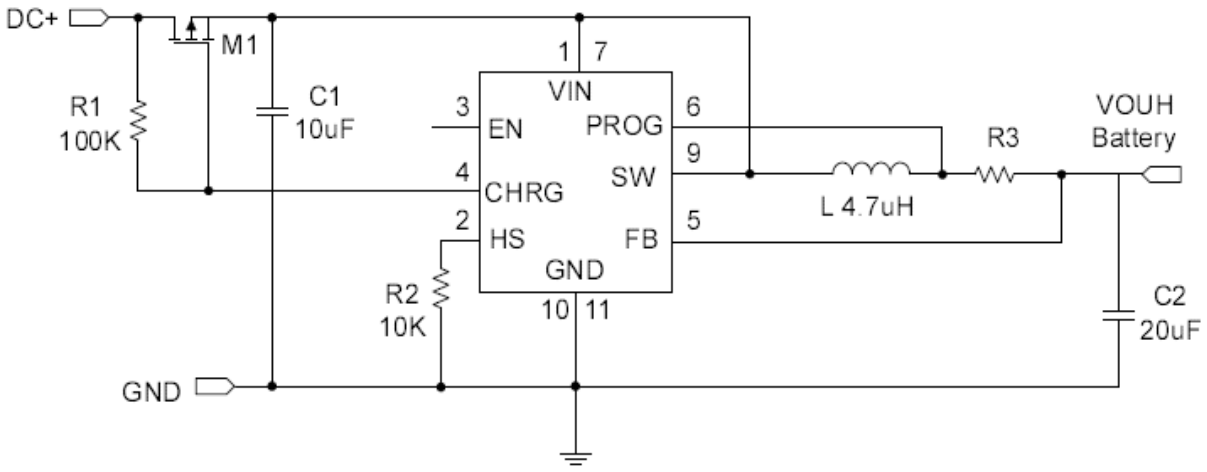
- **Charger for Li-Ion one Cell Batteries**
- **Portable MP3 Players**
- **Portable Computers，MID**

Typical Application

The charge current can be set by I_{OUT} = 0.103V/R3.

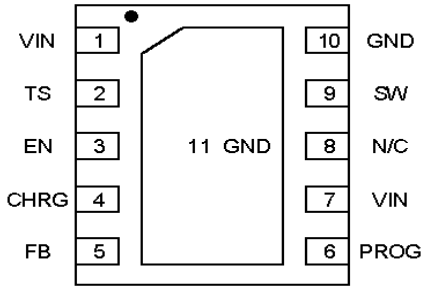


Figrue1: Using Schottky diode



Figrue2: Using P-Channel MOSFET

Pin Description

Part Number	Pin Configurations
SC61B15 **DFN3×3-10L**	

Pin Description

PIN	NAME	DESCRIPTION
1,7	VIN	Positive Input Supply Voltage. It Provides power to the charger VIN can range from 4.7V to 5V and should be bypassed with at least a 10uF capacitor.
2.	TS	Temperature Sense.
3.	EN	ON/OFF Control (High Enable)
4.	CHRG	Open-Drain Charge Status Output. When the battery is charging, the CHRG pin is pulled low by an internal N-channel MOSFET. When the charge cycle is completed or reverse battery lockout /No AC is detected, CHRG is forced high impedance.
5.	FB	Feedback Pin. Receives the feedback voltage from the output.
6.	PROG	Charge Current Program Pin. The output current is set by an external resistor according to the following formula: I_{OUT} = 0.103V/R3.
8.	N/C	No Used.
9.	SW	Switching node for Output. It provides charge current to the battery and regulates the final float voltage to 4.2V. An internal precision resistor divider from this pin sets the float voltage which is disconnected in shutdown mode.
10,11	GND	IC Ground. The exposed pad (DFN) must be soldered to PCB ground to provide both electrical contact and optimum thermal performance.

Absolute Maximum Ratings

- VIN, CHRG, SW, PROG Voltage ---------- –0.3V to 7V
- SW Pin Current ---------- 3.8A
- Operating Temperature Range ---------- –40℃ to 85℃
- Operating Junction Temperature ---------- –40℃ to 125℃
- Storage Temperature Range ---------- –65℃ to 125℃
- Lead Temperature (Soldering, 10 sec) ---------- 300℃

Electrical Characteristics

(Operating Conditions: T_A=25 ℃, V_{IN}=5V, R3 = 0.1Ω unless otherwise specified.)

SYMBOL	PARAMETER	CONDITIONS	SC61B15			UNITS
			MIN	TYP	MAX	
V_{IN}	Input Supply Voltage		4.7	5	5.5	V
I_{IN}	Input Supply Current	Charge Mode		170		μA
		Standby Mode (Charge Terminated)		180		
V_{FLOAT}	Regulated Output (Float) Voltage	0 ℃ ≤ TA ≤ 85 ℃, I_{OUT} =1.2A	4.15	4.2	4.24	V
I_{OUT}	VOUT Pin Current	Standby Mode, V_{OUT} = 4.2V		8.3		μA
		Shutdown Mode		8		
$V_{(LowV)}$	Precharge to fast-charge transition threshold	Voltage on output pin		2.85		V
I_{TRIKL}	Trickle Charge Current	V_{BAT} < V_{TRIKL}		103		mA
$V_{TS-COLD}$	TS Pin Threshold Voltage(cold)	V_{TS} from Low to High		2.84		V
V_{TS-HOT}	TS Pin Threshold Voltage(hot)	V_{TS} from High to Low		0.49		
I_{TS}	TS Pin Output Current			85		μA
I_{TERM}	Termination Current Threshold			160		mA
V_{FB}	FB Pin Voltage	Current Mode		0.1		V

Application Information

Functional Description

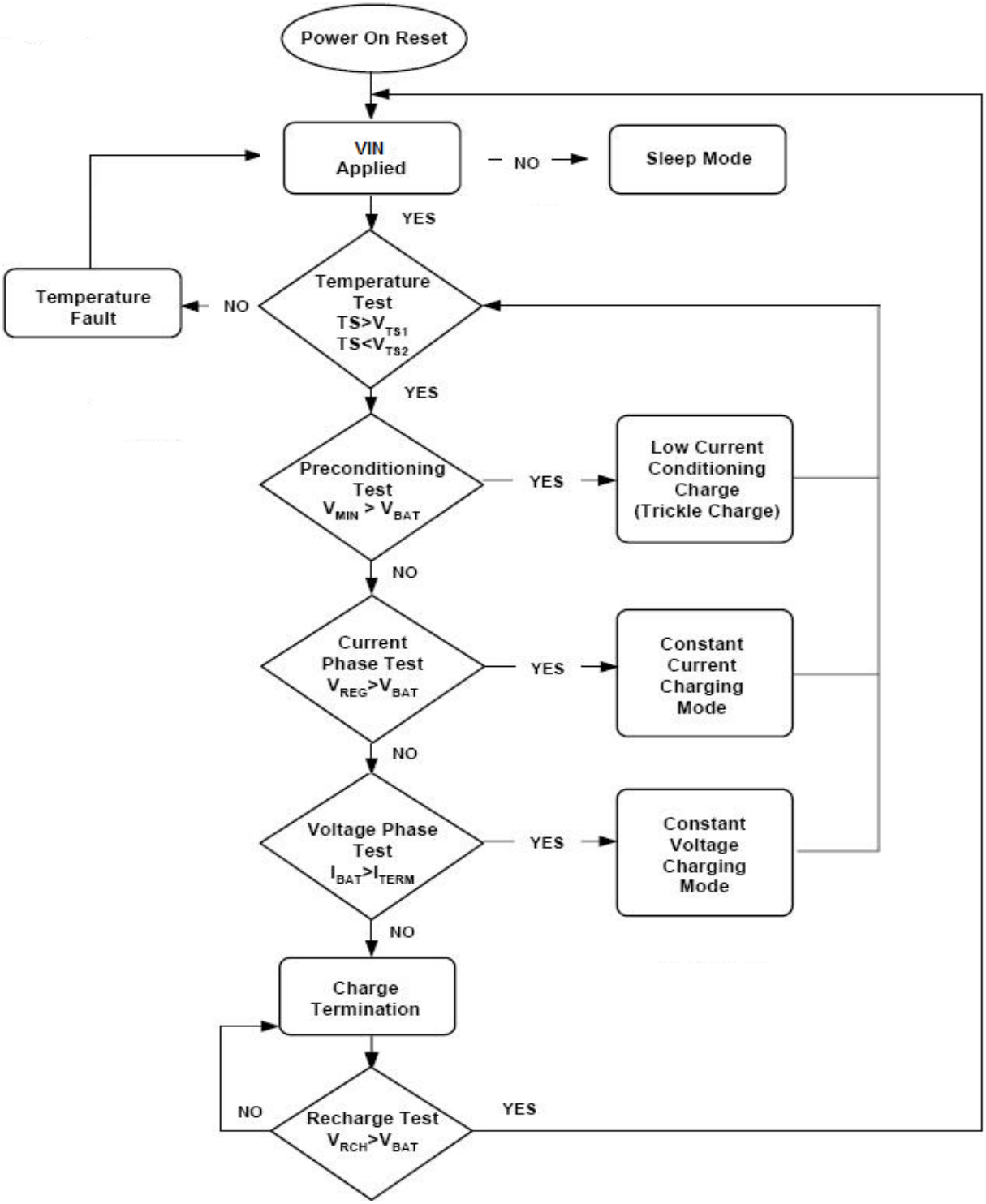
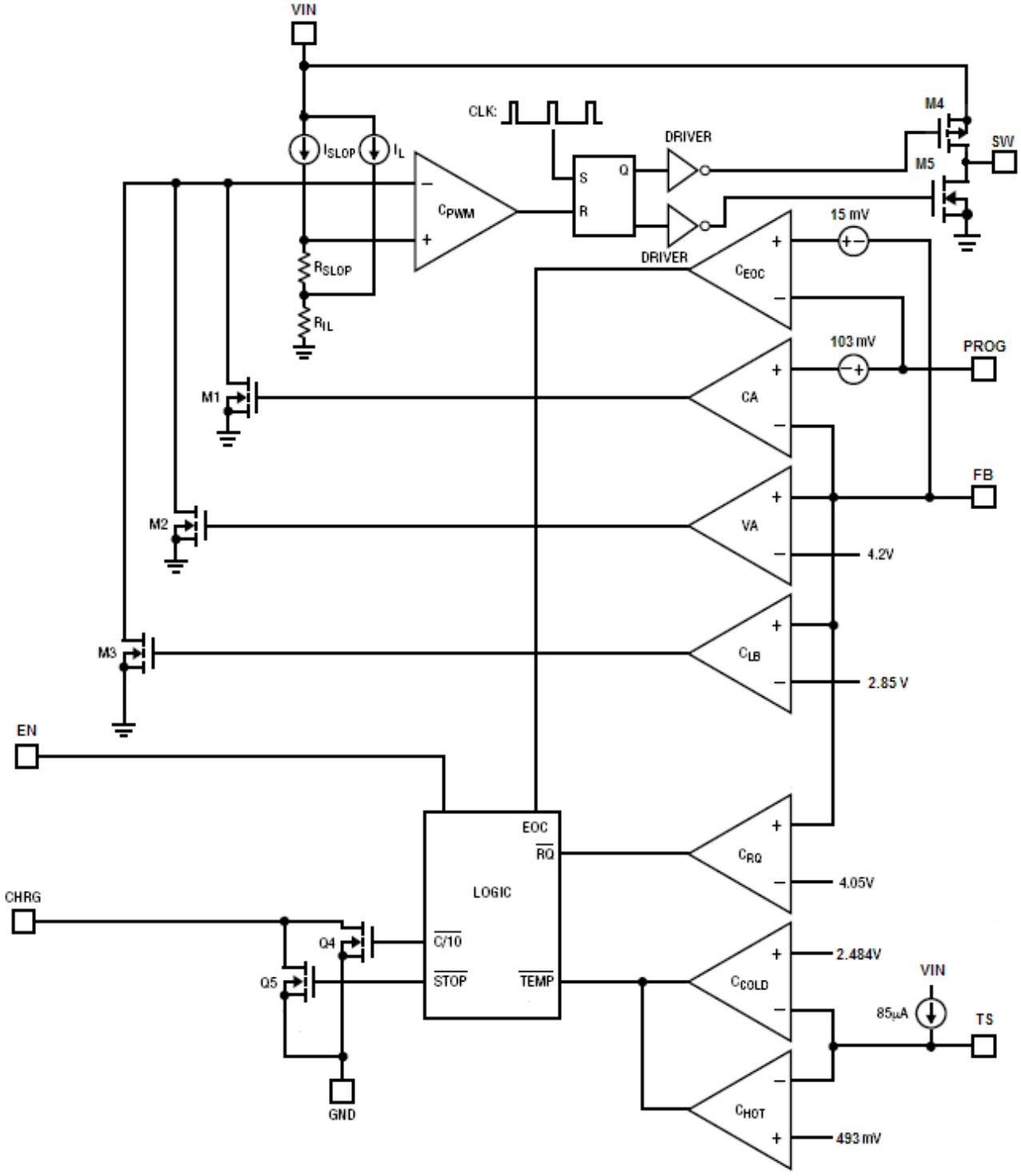


Figure 3: Operation Flow Chart

Block Diagram



Operation

The SC61B15 is a constant current, constant voltage Li-Ion battery charger controller that uses a current mode PWM step-down (buck) switching architecture. The charge current is set by an external sense resistor (R3) across the PROG and FB pins. The final battery float voltage is internally set to 4.2V. For batteries like lithium-ion that require accurate final float voltage, the internal reference, voltage amplifier and the resistor divider provide regulation with high accuracy.

A charge cycle begins when the voltage at the V_{IN} pin rises 250mV or greater than the battery voltage.At the beginning of the charge cycle, if the battery voltage is less than the trickle charge threshold, the charger goes into trickle charge mode. The trickle charge current is internally set to 12% of the full-scale 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 R3 and an internal 103mV reference; I_{OUT} = 103mV/R3.
When the battery voltage approaches the

programmed float voltage, the charge current will start to decrease.When the current drops to 12% of the full-scale charge current, an internal comparator turnsoff the internal pull-down N-channel MOSFET at the CHRG pin, and connects a weak current source toground to indicate a end-of-charge condition and then the charge cycle is terminated and the CHRG pinis forced high impedance.

To restart the charge cycle, remove and reapply the input voltage or momentarily shut the charger down.Also, a new charge cycle will begin if the battery voltage drops below the recharge threshold voltage.
When the input voltage is present, the charger can be shut down. When the input voltage is not present,the charger goes into sleep mode. This will greatly reduce the current drain on the battery and increasethe standby time.

A 10k TS (negative temperature coefficient) thermistor can be connected from the TS pin to ground forbattery temperature qualification.

Qualification and Precharge

The SC61B15 suspends charge if the battery temperature is outside the V_{TS1} to V_{TS2} range and suspends charge until the battery temperature is within the allowed range. The SC61B15 also checks the battery voltage. If the battery voltage is below the precharge threshold V(min) , the SC61B15 uses precharge to condition the battery. The conditioning charge rate I(PRECHG) is set at approximately 12% of the regulation current. See Figure 4 for a typical charge-profile.

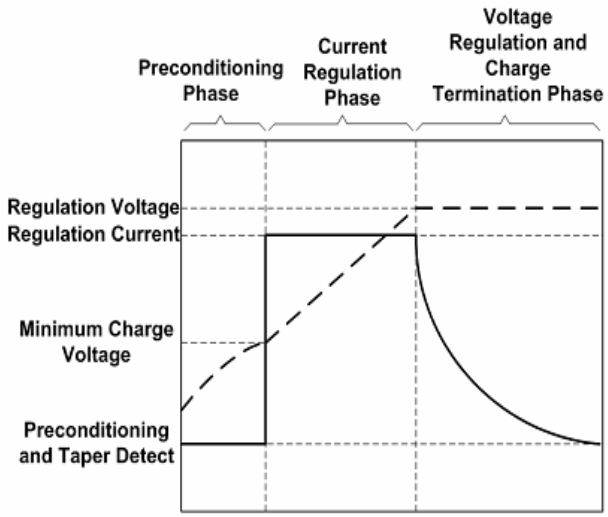


Figure 4

Charge Termination Recharge

The SC61B15 monitors the charging current during the voltage-regulation phase. The SC61B15 declares a done condition and terminates charge when the current drops to the charge termination threshold, ITERM. A new charge cycle begins when the battery voltage falls below the VRCH threshold.

Battery Temperature Monitoring

The SC61B15 continuously monitors temperature by measuring the voltage between the TS and GND pin. An internal current source provides the bias for most common 10-kΩ negative-temperature coefficient thermistors. The SC61B15 compares this voltage against its internal VTS1 and VTS2 thresholds to determine if charging is allowed. With the 85µA pull-up current source, the Hot temperature voltage threshold is 493mV. For Cold temperature, the voltage threshold is set at 2.484V with 85µA of pull-up current. The charge cycle begins or resumes once the temperature is within the acceptable range (See Figure 5).

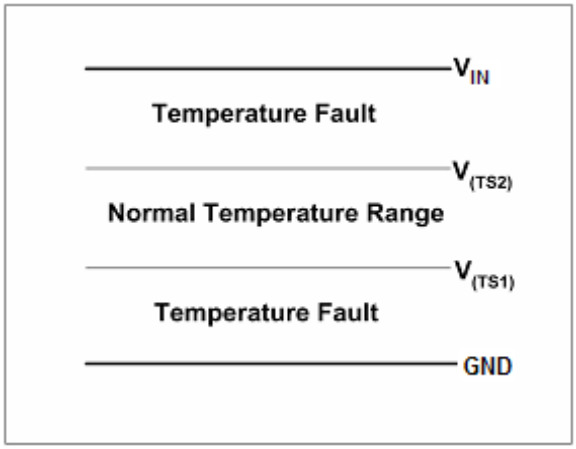


Figure 5

Charge Status Indication

The open-drain CHRG output indicates various charger operations as shown in the following table. This status pin can be used to drive LED or communicate to the host processor. Note that OFF indicates the open-drain transistor is turned off.

CHARGE STATE	CHRG
Battery conditioning and charging	ON
Charge complete(done)	OFF
Temperature fault or sleep mode	OFF

Table 1

Trickle Charge

At the beginning of a charge cycle, if the battery voltage is below the trickle charge threshold, the charger goes into trickle charge mode with the charge current reduced to 12% of the full-scale current.

Input and Output Capacitors

Since the input capacitor is assumed to absorb all input switching ripple current in the converter, it must have an adequate ripple current rating. Worst-case RMS ripple current is approximately one-half of output charge current. Actual capacitance value is not critical. Solid tantalum capacitors have a high ripple current rating in a relatively small surface mount package, but caution must be used when tantalum capacitors are used for input bypass. High input surge currents can be created when the adapter is hot-plugged to the charger and solid tantalum capacitors have a known failure

mechanism when subjected to very high turn-on surge currents. Selecting the highest possible voltage rating on the capacitor will minimize problems. Consult with the manufacturer before use. The selection of

$$\Delta V_{OUT} \le \Delta I_L \left(ESR + \frac{1}{8 f_{OSC} C_{OUT}} \right)$$

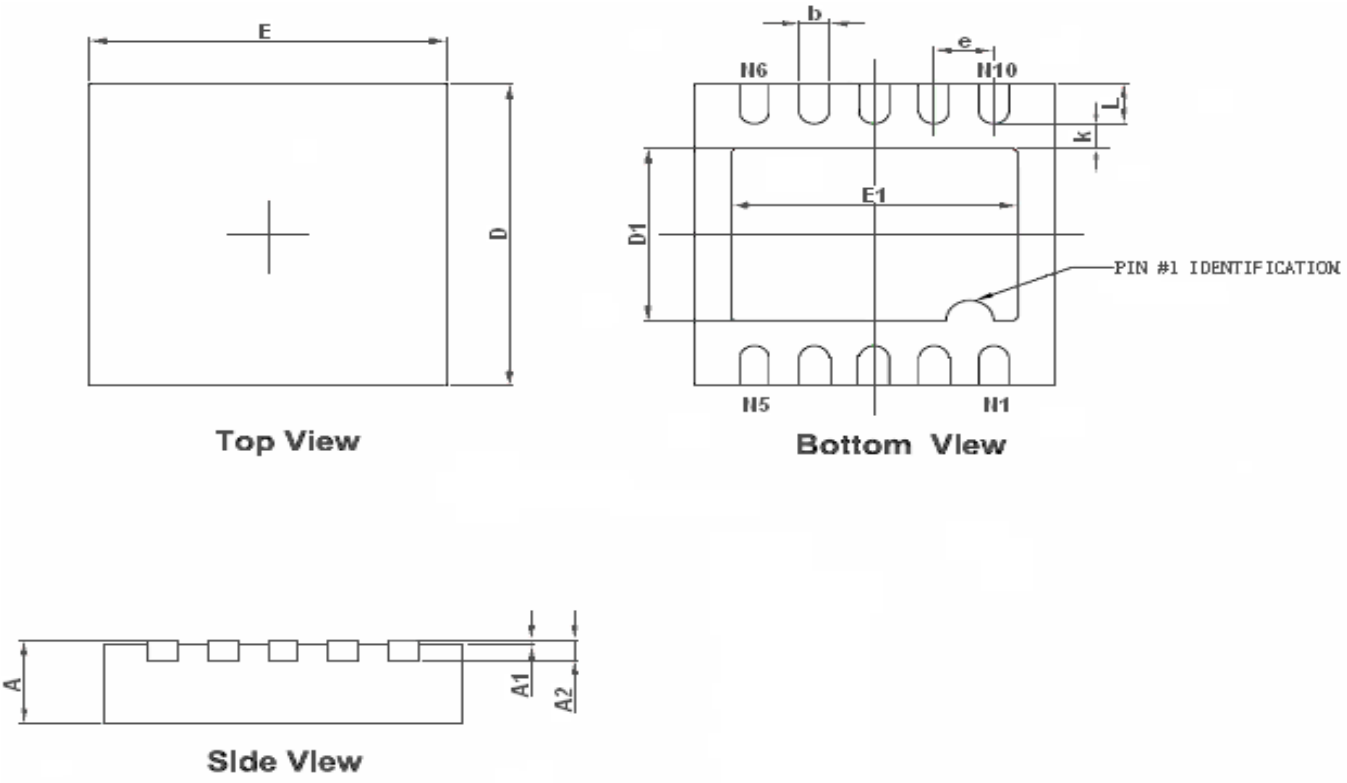
Since ΔIL increases with input voltage, the output ripple is highest at maximum input voltage. Typically, once the ESR requirement is satisfied, the capacitance is adequate for filtering and has the necessary RMS current rating.

Switching ripple current splits between the battery and the output capacitor depending on the ESR ofthe output capacitor and the battery impedance. EMI considerations usually make it desirable to minimize ripple current in the battery leads. Ferrite beads or an inductor may be added to increase battery impedance at the 500kHz switching frequency. If the ESR of the output capacitor is 0.2Ω and the battery impedance is raised to 4Ω with a bead or inductor, only 5% of the current ripple will flow in the battery.

output capacitor COUT is primarily determined by the ESR required to minimize ripple voltage and load step transients. The output ripple ΔVOUT is approximately bounded by:

Packging Information

DFN3*3-10L Package Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700/0.800	0.800/0.900	0.028/0.031	0.031/0.035
A1	0.000	0.050	0.000	0.002
A2	0.153	0.253	0.006	0.010
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
D1	1.600	1.800	0.063	0.071
E1	2.300	2.500	0.091	0.098
k	0.200MIN		0.008MIN	
b	0.200	0.300	0.008	0.012
e	0.500TYP		0.020TYP	
L	0.300	0.500	0.012	0.020