Two-Cell Li-Ion and Li-Polymer Charge Management IC

PRODUCT SUMMARY

Charge management for two-cell Li-Ion or Li-Polymer battery packs
Individual cell monitoring - avoids over-charging
TSSOP-8 small industry-standard package

FEATURES

Optional external thermistor monitors the pack temperature
Conditioning charge for reviving deeply discharged cells
Timer function available to limit the charging time

Pb-free, RoHS compliant.

DESCRIPTION

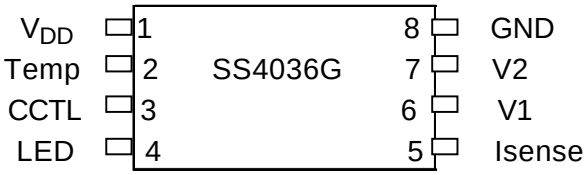
The SS4036G is a charging control IC designed for battery packs with two cells in series. When multiple cells in a battery pack are connected in series, the weakest cell determines the overall pack capacity. The SS4036G monitors the voltage of each cell toensure that no cell is overcharged. The pulse width modulation (PWM) output can be used as either a linear or switching charge-control circuit.

The small 8-pin TSSOP package is ideal for compact battery packs used for portable applications.

The SS4036G continuously monitors each cell voltage, cell current and the battery temperature. Any unspecified condition will stop the charging to to protect the battery cells. An external negative-temperature-coefficient thermistor is used as a sensor to monitor the battery pack temperature.

To be safe, charging is suspended if the voltage of the temperature sense input pin is higher than *Min Temp Threshold* (VTmin) or lower than *Max Temp Threshold* (VTmax). When the battery temperature is within the safe zone, the SS4036G charges the battery in three phases: pre-charging, constant-current, or constant-voltage. If the battery voltage is less than 3.1V, the SS4036G pre-charges the battery with a low current. After the pre-charging, the SS4036G applies a constant current to the battery. The value of this constant current is determined by the value of the current sense resistor. When the battery voltage is above the threshold, the SS4036G begins constant-voltage charging until the battery is fully charged. The battery is fully charged when the current drops down to the termination threshold.

PIN CONFIGURATION



PIN DESCRIPTION

Pin Name	Pin No	I/O	Description
VDD	1	P	Operating voltage input
Temp	2	A	Temperature sense voltage input
CCTL	3	O	Charging control (PWM) output
LED	4	O	Status indication
Isense	5	A	Current sense voltage input
V1	6	A	Cell 1 voltage (low side)
V2	7	A	Cell 2 voltage (high side)
GND	8	G	Ground

ABSOLUTE MAXIMUM RATINGS

DC Voltage …… -0.3V to +7.0V
I/O Voltage……. (GND-0.3V) TO (V_{DD}+0.3V)

Storage Temperature…… -55°C to +125°C
Operating Temperature……. -40°C to +85°C

* Stresses beyond those listed as “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 above those indicated in the operational sections of this specification is not implied or intended. Exposure to the absolute maximum rating condition for an extended period may affect device reliability.

ELECTRICAL CHARACTERISTICS

V_{DD} = 4.5V – 5.5V, GND = 0V, T_A = 25°C, f_{osc} = 4MHz, unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max	Unit	Condition
Operating Voltage	V_{DD}	4.5	5.0	5.5	V	
Operating Current	I_{OP}	-	1.5	2	mA	No load, ADC off
Standby Current	I_{SB}	-	-	1	uA	No load, ADC off, WDT off, LVR off
Output High Voltage	V_{OH}	VDD-0.7	-	-	V	All I/O, I_{OH} = -10mA
Output Low Voltage	V_{OL}	-	-	GND+0.6	V	All I/O, I_{OL}=20mA
Analog Input	A_{in}	GND		VDD	V	Temp, Isense, V1, V2

ELECTRICAL CHARACTERISTICS (continued)

V_{DD} = 5V, GND = 0V, T_A = 25°C, f_{osc} = 4MHz, R_{sens}=100mΩ, unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max	Unit	Description
Voltage Control						
Precharge Threshold	V_{low}	-	3.10	-	V	
CC/CV Threshold	V_{cv}	-	4.15	-	V	Switch to CV mode above this value
Max Cell Voltage	V_{max}	-	4.25	-	V	Maximum cell voltage
Bad Battery Threshold	V_{bad}	-	0.5	-	V	Difference between V1 and V2
Temperature Sensing						
Low Temp Threshold	VT_{low}	-	3.03	-	V	Upper limit of temperature-sense voltage
High Temp Threshold	VT_{high}	-	1.53	-	V	Lower limit of temperature-sense voltage
Resume Threshold	VT_{rsm}	-	1.84	-	V	Threshold for resuming charging
Current Control						
Precharge Current	I_{pre}	-	20/Rsense	-	mA	See note 1 below.
Charge Current	Ichg	-	100/Rsense	-	mA	See note 1 below.
Taper Current	I_{taper}	-	20/Rsense	-	mA	See note 1 below. Fully charged if the taper current is below this value
Time Control						
Max Charge Time	T_{chg}		340		min	Maximum charging time allowed

Note 1: The SS4036G monitors charging current by sensing, at the input pin Isense (5), the voltage drop across a sense resistor, Rsense - see the explanation on page 7.

FUNCTIONAL DESCRIPTION

A well-known Li-Ion charge algorithm is used by the the SS4036G to control the charging. Figure 1 shows shows the typical charge profile. Figure 2 is the control flow chart. During the process of charging, the SS4036G continuously monitors each cell voltage, current and the battery temperature. Any unqualified condition will stop the charging to protect the battery cells.

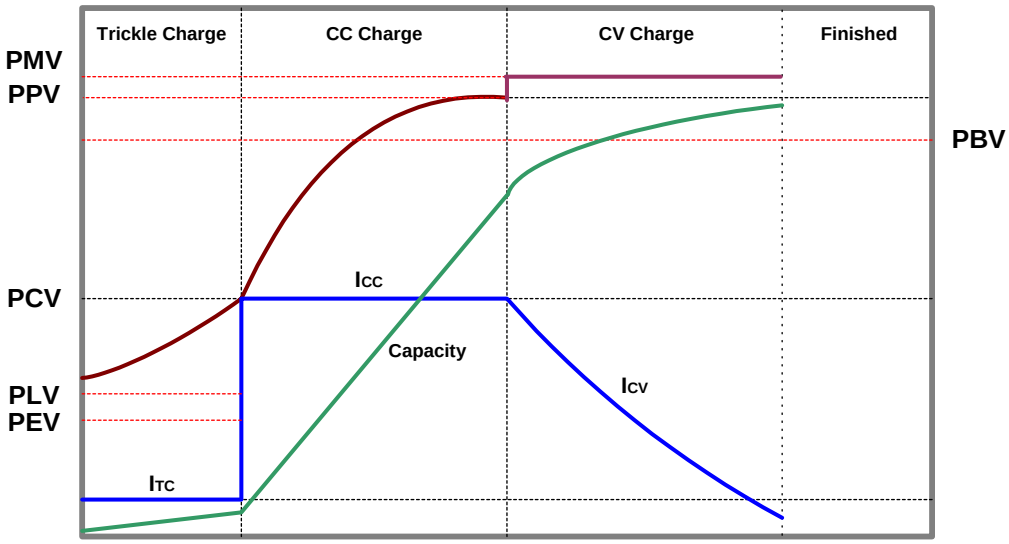


Figure 1. Typical Charge Profile

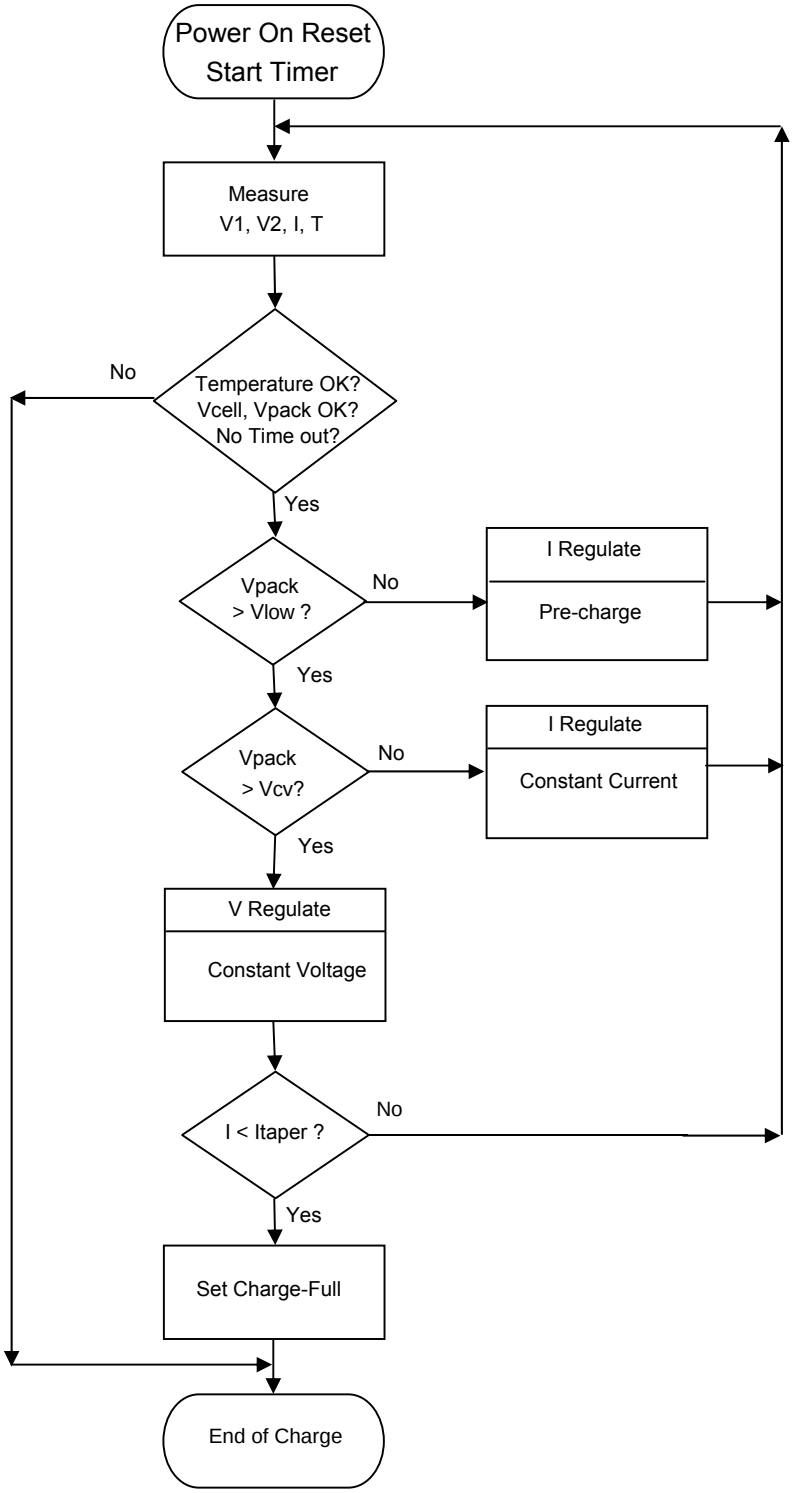


Figure 2. Control Flow Chart

VOLTAGE, CURRENT AND TEMPERATURE SENSING

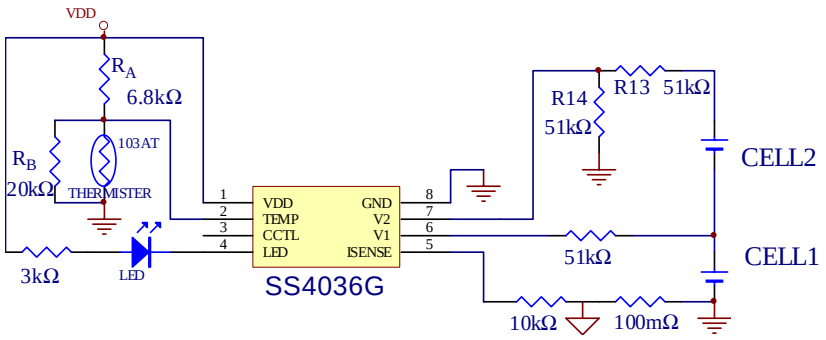


Figure 3. Cell voltage, current sense and temperature sensor

Figure 3 shows the cell voltage sense, current sense sense and temperature detecting circuit. The pack pack voltage is divided by 2 (by using two equal resistors, R13 and R14). This guarantees that the the voltage on the V2 input pin (7) will not exceed V_{DD}. The SS4036G monitors the charge current by measuring at the Isense input pin (5) the voltage drop across a sense resistor, connected between VSS (battery negative) and GND (Charger ground). The value of this resistor should be between 50mΩ and 150mΩ .

To detect the temperature, a negative-temperature-coefficient thermistor is used as a sensor. A 103AT sensor. A 103AT and a voltage divider (resistor R_A and R_B) are recommended.

The resistor values for R_A and R_B are calculated using the following equations:

$$RA = \frac{1.615 \times Rc \times Rh}{Rc - Rh}$$

$$RB = \frac{5 \times Rc \times Rh}{2Rc - 7Rh}$$

Where,

V_{DD} is 5V

Rc is the cold temperature resistance

Rh is the hot temperature resistance

RA, RB are in kΩ .

Example :

For thermistor 103AT, the hot temperature temperature is 55°C and the cold temperature is 5°C, then R_A = 6.8kΩ , R_B= 20kΩ .

The temperature detection can be disabled by connecting the Temp pin (2) to V_{DD}.

CHARGING CONTROL

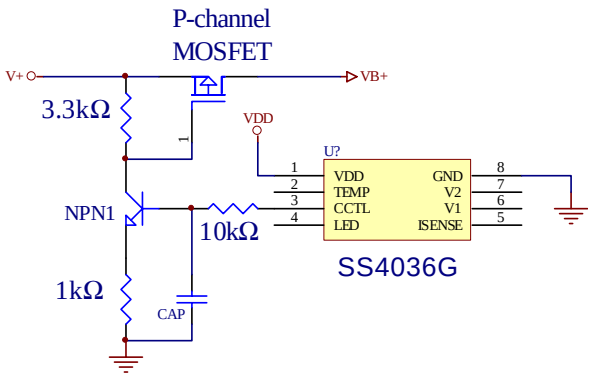


Figure 4. Charging Control

Figure 4 shows the linear charger circuit using the SS4036G. The output of pin CCTL (3) is a pulse-width-modulated (PWM) signal. This signal is translated to a DC voltage to control the P-channel MOSFET which is working in the active region. This P-channel MOSFET must be chosen carefully to handle the required power dissipation.

CHARGING STATUS INDICATION

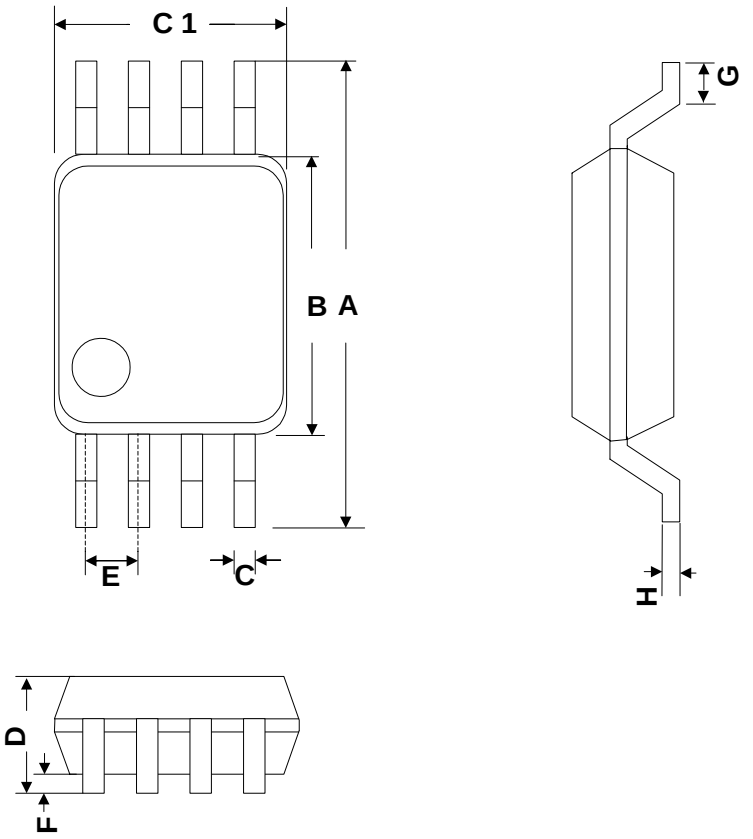
The LED (4) output pin can sink at most 20mA to light up the LED. Table 1 summarizes the operation of this LED pin.

Table 1. Charging Status

LED pin output	Condition
High	Normal charging
Low	Fully charged
4 Hz square signal	Bad battery, charging continued
Hi-Z	Temperature fault, charging suspended

PHYSICAL DIMENSIONS (units: inches)

TSSOP-8



Symbol	Dimension in mm		
	min.	nom.	max.
A	6.2	-	6.6
B	4.2	-	4.6
C	0.1	-	0.3
C1	2.8	-	3.3
D	-	-	1.1
E	-	0.65	-
F	0.05	-	0.10
G	-	0.50	-
H	0.12	-	0.22

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