SY6912A
2A Multi-Cell High Efficiency Switching Charger
Preliminary Specification

General Description

SY6912A is a 4.0-23V input, 2A multi-cell synchronous Buck Li-Ion battery charger, suitable for portable application. Select pin is convenient for multi-cell charging. 800 kHz synchronous buck regulator integrates of 23V rating FETs with ultra low on- resistance to achieve high efficiency and simple circuit design.

Ordering Information

SY6912 □(□□)□
- Temperature Code
- Package Code
- Optional Spec Code

Temperature Range: -40°C to 85°C

Ordering Number	Package type	Note
SY6912AFCC	SO8E	

Features

- Wide Input Voltage Range: 4.0V to 23V
- High Efficiency Int. Synchronous Buck Regulator with Fixed 800kHz Switching Frequency
- Selectable for Multi-cell Charging
- Trickle Current / Constant Current / Constant Voltage Charge Mode
- Programmable (2A Max) Constant Charge Current
- Programmable Charging Timer
- Input Voltage UVLO and Battery OVP
- Over Temperature Protection
- Output Short Circuit Protection
- Automatic Shutdown Prevents Reverse Energy Flow
- Charge Status Indication
- Normal Synchronous Buck Operation when Battery Removed
- Compact package SO8E

Applications

- Cellular Telephones,
- PDA, MP3 Players, MP4 Players
- Digital Cameras
- Bluetooth Applications
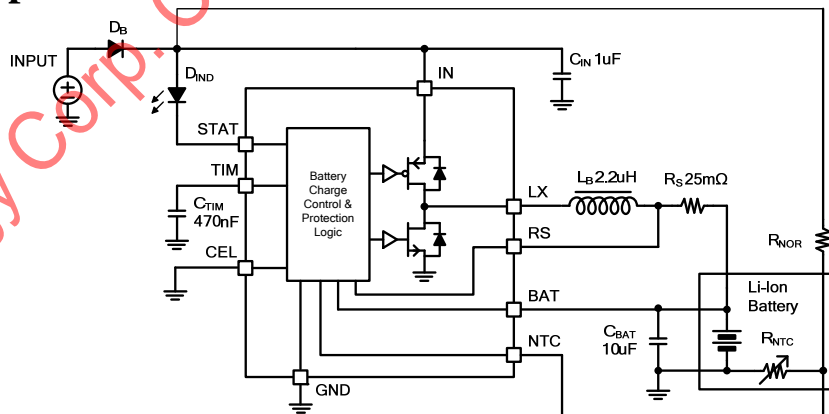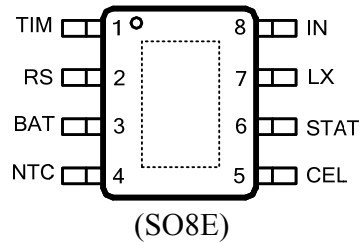- PSP Game Players, NDS Game Players
- Notebook

Typical Applications

Figure 1. SY6912A Schematic Diagram

Pinout (top view)

```
        TIM  ┌─┐ 1 ○      8 ┌─┐  IN
        RS   ┌─┐ 2        7 ┌─┐  LX
        BAT  ┌─┐ 3        6 ┌─┐  STAT
        NTC  ┌─┐ 4        5 ┌─┐  CEL
```

(SO8E)

Top Mark: AIQ*xyz* (device code: **AIQ**, *x=year code, y=week code, z= lot number code)*

Name	Number	Description
RS	1	Charge current program pin. Connect a current sense resistor from RS pin to BAT pin. Average charge current is detected for both TC mode and CC mode.
BAT	2	Battery positive pin.
NTC	3	Thermal protection pin. UTP threshold is about $75\%V_{IN}$ and OTP threshold is about $30\%V_{IN}$. Pull up to VIN can disable charge logic and make the IC operate as normal buck regulator. Pull down to ground can shutdown the IC.
CEL	4	Pull down for single-cell, pull high for 2 cells, open for 3 cells.
STAT	5	Charge status indication pin. It is open drain output pin and can be used to turn on a LED to indicate the charge in process. When the charge is done, LED is off.
LX	6	Switch node pin. This pin connects the drains of the integrated main and synchronous power MOSFET switches. Connect to external inductor.
IN	7	Positive power supply input pin. V_{IN} ranges from 4V to 23V for normal operation. It has UVLO function and must be 300mV greater than the battery voltage to enable normal operation.
TIM	8	Charge time limit pin. Connect this pin with a capacitor to ground. Internal current source charge the capacitor for TC mode and CC mode's charge time limit. TC charge time limit is about 1/9 of CC charge time.
GND	Exposed pad	Ground pin.

Absolute Maximum Ratings (Note 1)

CEL, NTC, STAT, --- -0.5-32V
IN, BAT, LX, -- -0.5- 23V
TIM, --- -0.5- 3.6V
RS, -- BAT-0.3~BAT+0.3
LX Pin current continuous --- 2A
Power Dissipation, P_D @ T_A = 25°C SO8E--- 3.3W
Package Thermal Resistance (Note 2)
         θ_{JA} -- 30°C/W
         θ_{JC} -- 20°C/W
Junction Temperature Range -- -40°C to 125°C
Lead Temperature (Soldering, 10 sec.) -- 260°C
Storage Temperature Range --- -65°C to 125°C

Recommended Operating Conditions(Note 3)

CEL,NTC, STAT, ---less than 32V
IN, BAT, LX, --less than 23V
TIM, --less than 3.6V
RS, -- in the range of BAT-
0.3~BAT+0.3LX Pin current continuous ---
less than 2A
Junction Temperature Range --------- -- -20°C to 100°C
Ambient Temperature Range --- -40°C to 85°C

Electrical Characteristics

T_A=25°C, V_{IN}=15V, GND=0V, C_{IN}=1uF, L_B=2.2uH, R_S=25mΩ, C_{TIM}=470nF, unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Bias Supply (V_{IN})						
V_{IN}	Supply voltage		4.0		23	V
V_{UVLO}	V_{IN} under voltage lockout threshold	V_{IN} rising and measured from V_{IN} to GND			3.9	V
ΔV_{UVLO}	V_{IN} under voltage lockout hysteresis	Measured from V_{IN} to GND		190		mV
V_{OVP}	Input overvoltage protection	V_{IN} rising and measured from V_{IN} to GND			24	V
ΔV_{OVP}	Input overvoltage protection hysteresis	Measured from V_{IN} to GND		750		mV
Quiescent Current						
I_{BAT}	Battery discharge current	NTC pull down to GND			25	uA
I_{IN}	Input quiescent current	Disable Charge			2.0	mA
Oscillator and PWM						
f_{OSC}	Oscillator frequency		640	800	960	kHz
D	PFET duty cycle				100	%
Power MOSFET						
R_{NFET}	$R_{DS(ON)}$ of N-FET			150		mΩ
R_{PFET}	$R_{DS(ON)}$ of P-FET			160		mΩ
Voltage Regulation						
V_{CV}	Single-cell CV charge mode	0°C <=T_A<=70°C	4.16	4.20	4.24	V
	2-cell CV charge mode		8.32	8.40	8.48	
	3-cell CV charge mode		12.48	12.60	12.72	
ΔV_{RCH}	Single-cell Voltage threshold for Recharge	0°C <=T_A<=70°C	50	100	150	mV
	2-cell Voltage threshold for Recharge		100	200	300	
	3-cell Voltage threshold for Recharge		150	300	450	
V_{TRK}	Single-cell TC charge mode voltage threshold	0°C <=T_A<=70°C	2.2	2.5	2.8	V
	2-cell TC charge mode voltage threshold		4.4	5.0	5.6	
	3-cell TC charge mode voltage threshold		6.6	7.5	8.4	
Battery Connect Detection						
V_{DET}	Detect voltage threshold	V_{SHOT}< V_{BAT}< V_{RCH}	80%		90%	V_{IN}
t_{DET}	Detect delay time			30		ms
Charge Current						
	Internal charge current accuracy for Constant Current Mode	I_{CC}=25mV/R_S	-10%		10%	
	Internal charge current accuracy for Trickle Current Mode	I_{TC}=2.5mV/R_S	-50%		50%	
Output Voltage OVP						
V_{OVP}	Output voltage OVP threshold		108%	113%	118%	V_{CV}
Output Short Protection						
V_{SHOT}	Output short protection threshold	V_{BAT} falling edge	1.70	2.00	2.30	V
f_{FBK}	Frequency fold back	V_{BAT}<2V		12.5%		f_{OSC}
I_{LM}	Power FET current limit			4.0		A
Timer						
T_{TC}	Trickle current charge timeout	C_{TIM}=330nF	0.23	0.5	0.67	hour
T_{CC}	Constant current charge timeout		3.0	4.5	6.0	hour
T_{MC}	Charge mode change delay time			30		ms
T_{TERM}	Termination delay time			30		ms
T_{RCHG}	Recharge time delay			30		ms
Battery Thermal Protection NTC						
UTP	Under temperature protection		70%	75%	80%	V_{IN}
	Under temperature protection hysteresis	Falling edge		5%		
OTP	Over temperature protection		28%	30%	32%	
	Over temperature protection hysteresis	Rising edge		2%		
Automatic Shutdown						
ΔV_{ASD}	ASD voltage threshold hysteresis	Measured from V_{IN} to V_{BAT}	140	280	420	mV

Note 1: Stresses beyond the "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note 2: θ_{JA} is measured in the natural convection at $T_A = 25°C$ on a low effective four-layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

Note 3: The device is not guaranteed to function outside its operating conditions

Basic Li-Ion Battery Charge Operation Flow Chart
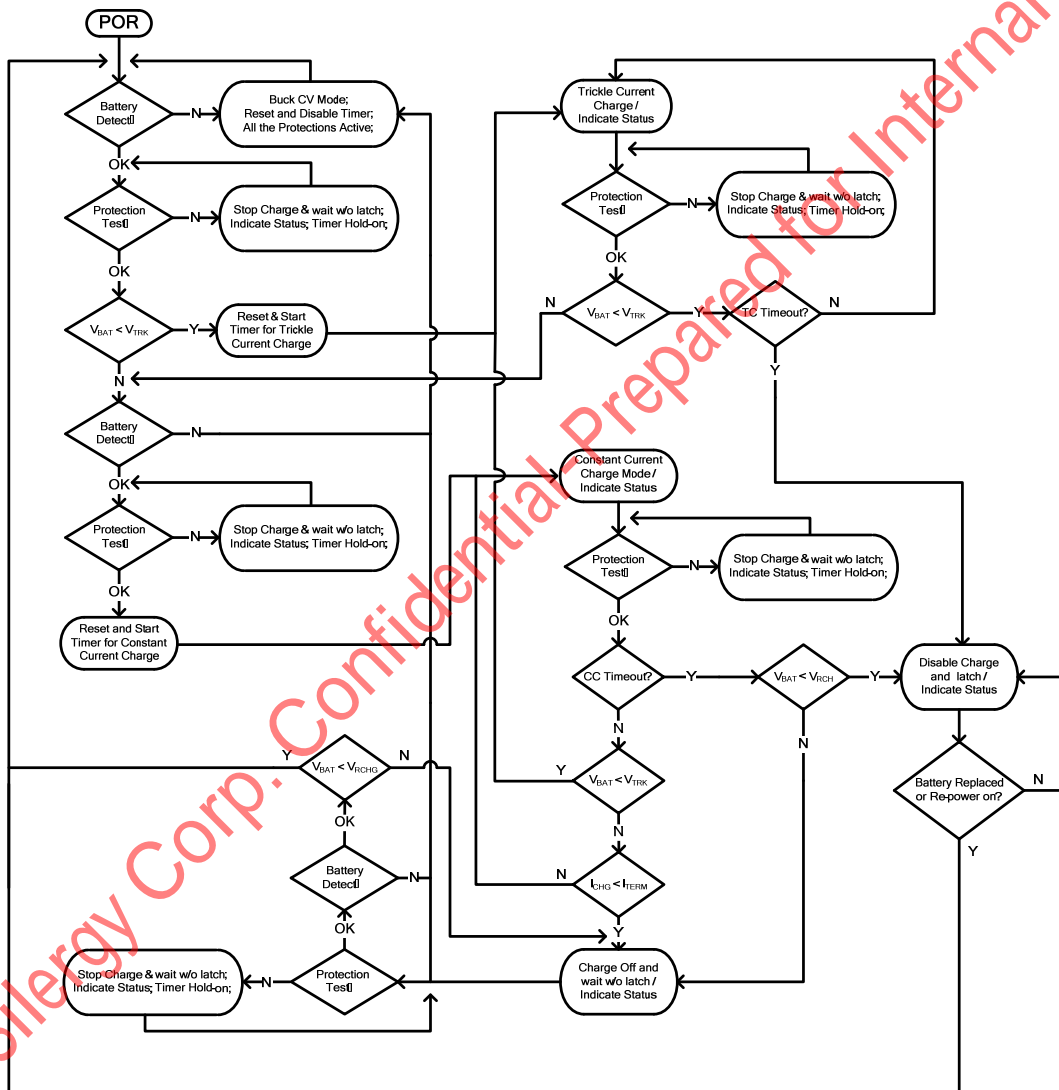
General Function Description

SY6912A is a 4.0-23 input, 2A multi-cell synchronous buck Li-Ion battery charger, suitable for portable application. Select pin is convenient for multi-cell charging. Integrated 800 kHz synchronous buck regulator consists of 23V rating FETs with extremely low on-resistance to achieve high charge efficiency and simple circuit design.

Charging Status Indication Description

1. **Charge-In-Process** – Pulls and keeps STAT pin to Low;
2. **Charge Done** – Pulls and keeps STAT pin to High;
3. **Fault Mode** – Outputs high and low voltage alternatively with 0.5Hz frequency.

Connects a LED from VIN to STAT pin, **LED ON** indicates **Charge-in-Process**, **LED OFF** indicates **Charge Done**, **LED Flash** indicates **Fault Mode**.

Buck Regulator Operation Description

If the Li-Ion battery is removed suddenly, the voltage on NTC pin increases higher than 90% Vin. Then, it operates as a normal peak current mode controlled synchronous buck converter and the output voltage on BAT pin is regulated at V_{CV}. In this operation mode, the constant output current loop is still active, however the charge timeout and the trickle current charge are disabled.

Protection Description

Thermal Protection-Thermal shutdown is active for both battery and IC. IC resumes normal work when the temperature backs in normal range again.
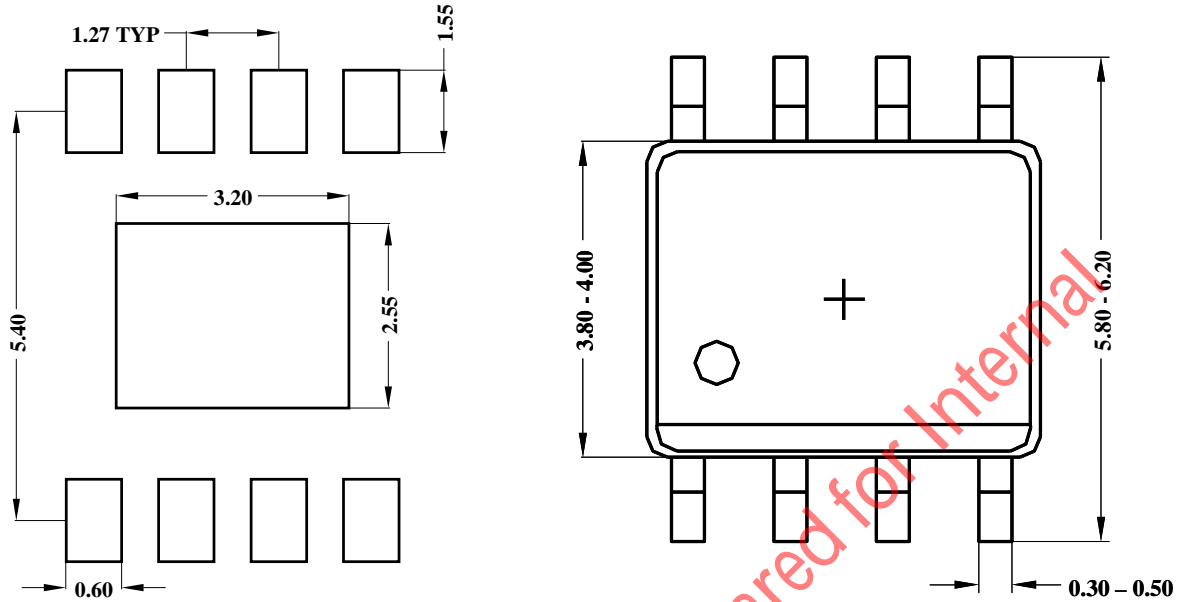
Short Circuit Protection- When V_{BAT} voltage is lower than the short circuit protection threshold, short circuit protection is active. In charger operation mode, the switching frequency is folded back to 12.5% of the default value and VC is folded back to 20% of the maximum value. The trickle charge timer is still active and would timeout the IC finally. In Buck operation mode, the switching frequency is folded back to 12.5% of the default value, and the VC initiates softstart periodically.

Over Current Protection-The internal current loop with different constant current capability is always active no matter in Buck mode or Battery Charging mode for the over current protection.
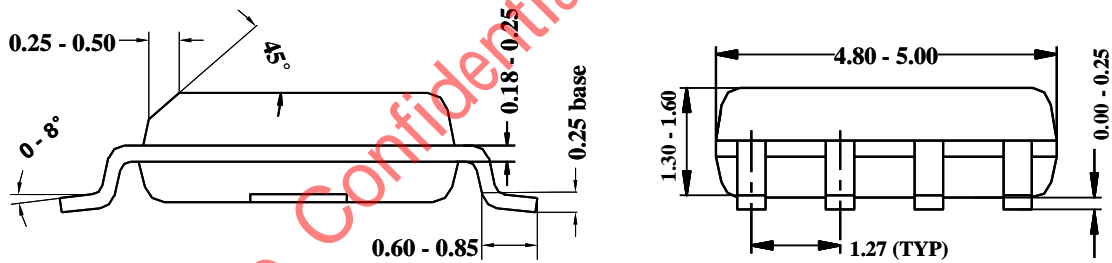
Over Voltage Protection-When V_{BAT} voltage is higher than the over voltage protection threshold no matter with or without battery connecting, IC shuts down and recovers to normal work when V_{BAT} backs to normal level. Input voltage has UVLO and OVP, which would make IC shutdown and recover to normal work when the V_{IN} backs to normal range.

Timeout Protection-Programmable timeout protection is for both Trickle Current Charge Mode and Constant Current Charge Mode. Once timeout is active, IC stops the charge operation and latches off. Only power or battery re-plug in can get the latch logic reset and the IC restarted.

SO8E Package outline & PCB layout design

1.27 TYP   1.55

3.20

2.55

5.40

0.60

Recommended Pad Layout

3.80 - 4.00   5.80 - 6.20

0.30 – 0.50

0.25 - 0.50   45°   0.18 - 0.25   0.25 base

0 - 8°

0.60 - 0.85

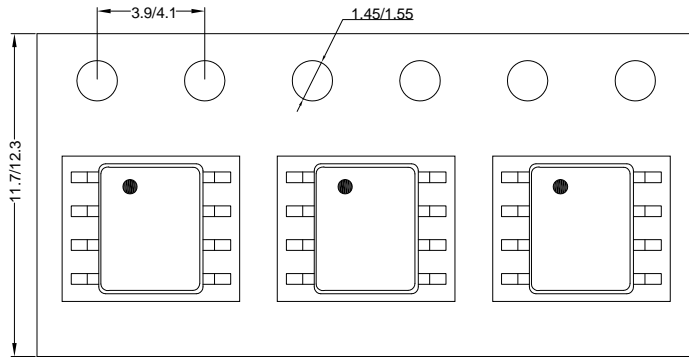4.80 - 5.00   0.00 - 0.25

1.30 - 1.60

1.27 (TYP)

Notes: All dimensions are in millimeters.
All dimensions don't include mold flash & metal burr.
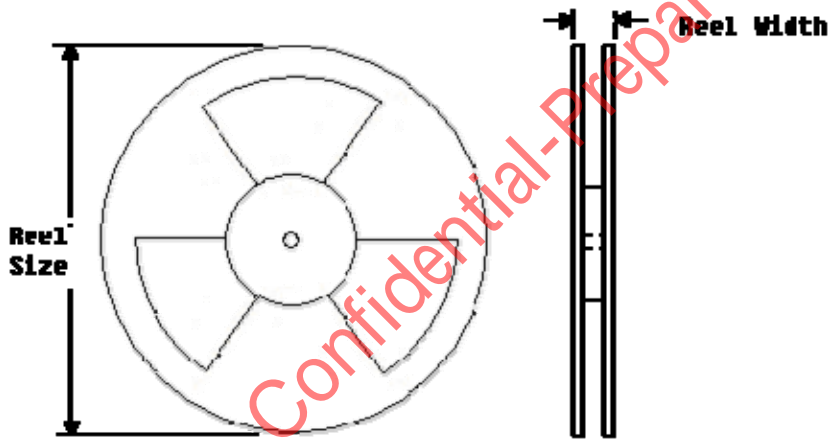
Taping & Reel Specification

1. Taping orientation

SO8E

Feeding direction ⟶

2. Carrier Tape & Reel specification for packages

Package types	Tape width (mm)	Pocket pitch(mm)	Reel size (Inch)	Reel width(mm)	Trailer length(mm)	Leader length (mm)	Qty per reel
SO8E	12	8	13"	12.4	400	400	2500

3. Others: NA