Silan Semiconductors

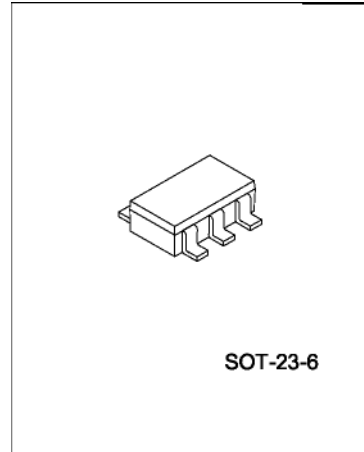**LI-ION BATTERY PROTECTOR**

SC451

DESCRIPTION

SC451 is a series of lithium ion and lithium polymer rechargeable battery protection ICs with high accurate voltage detection and delay circuits.

These ICs are suitable for protection of single cell lithium ion or lithium polymer battery packs from over charge, over discharge, and over current.

FEATURES

* Low supply current
* Overcharge detect *
Overcharge release
* Overdischarge detect *
Overdischarge release *
Over current 1 detect
* Over current 2(Short Current) detect *
Overcharge detection delay * Charger detect
* Reset resistance for Over current protect *
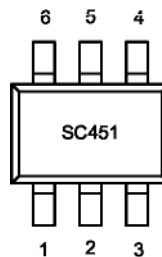Wide supply voltage range * Small package

SOT-23-6

ORDERING INFORMATION

Device	Package
SC451	SOT-23-6

APPLICATIONS

* Protection IC for One-Cell Lithium-Ion Battery Pack

PIN ASSIGNMENT

SHENZHEN SUN-SHING SCIENCE&TECHNOLGY CO.,LTD
THE SHENZHEN AGENCY OF SILAN   Tel:0755-26221076

| Silan Semiconductors | **SC451** |

ABSOLUTE MAXIMUM RATING

Characteristic	Symbol	Value	Unit
Supply Voltage Between V_{DD} and V_{SS}	V_{DD}	V_{SS}-0.3 to V_{SS}+12	V
OC Output Pin Voltage	V_{OC}	V_{DD}-15 to V_{DD}+0.3	V
OD Output Pin Voltage	V_{OD}	V_{SS}-0.3 to V_{SS}+0.3	V
CSI Input Pin Voltage	V_{CSI}	V_{DD}-15 to V_{DD}+0.3	V
Operating Temperature Range	T_{OP}	-10 ~ + 70	°C
Storage Temperature Range	T_{ST}	-40 ~ +125	°C

ELECTRICAL CHARACTERISTICS (T_{amb}=25° C, unless otherwise specified)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Current consumption						
Supply Current	I_{DD}	V_{DD}=3.9V		3.0	6.0	μA
Power-Down Current	I_{PD}	V_{DD}=2.0V		0.3	0.6	μA
Operating voltage						
Operating Voltage Between V_{DD} and V_{SS}	V_{DD}		1.8		8.0	V

(To be continued)

SHENZHEN SUN-SHING SCIENCE&TECHNOLGY CO.,LTD
THE SHENZHEN AGENCY OF SILAN   Tel:0755-26221076

Rev: 1.3   2004.10.13

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Detection voltage						
Overcharge Detection Voltage	V_{OCU}		4.275	4.325	4.375	V
Overcharge Release Voltage	V_{OCR}		4.05	4.15	4.25	V
Overdischarge Detection Voltage	V_{ODL}		2.30	2.40	2.50	V
Overdischarge Release Voltage	V_{ODR}		2.90	3.00	3.10	V
Over Current 1 Detection Voltage	V_{OI1}		0.12	0.15	0.18	V
Over Current 2 (Short Current) Detection Voltage	V_{OI2}	V_{DD}=3.6V	1.25	1.35	1.45	V
Reset Resistance for Over Current Protection	Rshort	V_{DD}=3.6V	400	500	600	k~
Charger Detection Voltage	V_{CH}		-0.8	-0.6	0.4	V
Delay time						
Overcharge Detection Delay Time	TOC	CTD=0.01uF	50	100	150	ms
Overdischarge Detection Delay Time	TOD	V_{DD}=3.6V to 2.0V	5	10	15	ms
Over Current 1 Detection Delay Time	TOI1	V_{DD}=3.6V	5	10	15	ms
Over Current 2 (Short Current) Detection Delay Time	TOI2	V_{DD}=3.6V		5	50	μs
Other						
OC Pin Output " H " Voltage	Voh1		V_{DD}-0.1	V_{DD}-0.02		V
OC Pin Output "L" Voltage	Vol1			0.01	0.1	V
OD Pin Output " H " Voltage	Voh2		V_{DD}-0.1	V_{DD}-0.02		V
OD Pin Output "L" Voltage	Vol2			0.01	0.1	V

PIN DESCRIPTION

PIN No.	Symbol	Description
1	OD	FET gate connection pin for discharge control
2	CSI	Input pin for current sense, charger detect
3	OC	FET gate connection pin for charge control
4	TD	Pin for external capacitor setting output delay of V_{OCU}
5	V_{DD}	Positive power input pin
6	V_{SS}	Negative power input pin

FUNCTIONAL DESCRIPTION

Normal Condition

If $V_{ODL}<V_{DD}<V_{OCU}$ and $V_{CH}<V_{CSI}<V_{OI1}$, M1 and M2 are both turned on. The charging and discharging processes can be operated normally.

Overcharge Detection

If the battery voltage detected from V_{DD} reaches a certain value, charging from a charger is inhibited for overcharge protection. When V_{DD} is larger than V_{OCU} over a delay time of TOC, M2 is to be turned off.

Release of Overcharge Condition

There are two ways to return to normal condition from overcharge condition.
- If the battery is self discharging and $V_{DD}<V_{OCR}$ occurs, M2 is to be turned on and back to normal condition.
- Remove the charger and connected to a load. If $V_{OCR}<V_{DD}<V_{OCU}$ and $V_{CSI}>V_{OI1}$ occurs, M2 is to be turned on and back to normal condition.

Overdischarge Detection

If the battery voltage detected from V_{DD} is lower to a certain value, discharge to a load stops. V_{DD} is smaller than V_{ODL} over a delay time of TOD; M1 is to be turned off. In the meanwhile, CSI is pulled to V_{DD} by way of internal resistance, RCSID. If $V_{CSI}>V_{OI2}$, the protection IC enters into Power-down mode. (Its current consumption is lower than 0.3uA).

Release of Power-down mode

A charger is connected while the battery remains in Power-down mode. If $V_{CH}<V_{CSI}<V_{OI2}$ and $V_{DD}<V_{ODR}$ occur, M1 is still off but it releases Power-down mode. If $V_{DD}>V_{ODR}$ occurs, M1 is to be turned on and back to normal condition.

Charger Detection

If a charger is connected to the battery remained in Power-down mode, the voltages will become $V_{CSI}<V_{CH}$ and $V_{DD}>V_{ODL}$. M1 is to be turned on and back to normal condition.

Abnormal Charging Condition

If a charger is connected to the battery in normal condition, $V_{CSI}<V_{CH}$ occurs for a delay time longer than TOC, M2 is to be turned off.

Over Current/Short Current Detection

When the discharging current is too large during discharging under normal condition and the voltage detected from CSI is larger than V_{OIX} (V_{IO1} or V_{IO2}) for over a certain delay time T_{OIX} (T_{IO1} or T_{IO2}), it means the over current/short current condition occurred. M1 is turned off. CSI is pulled to V_{SS} by way of an internal resistance, RCSIS.

Release of Over Current/Short Current Condition

While the protection IC remains in Over Current/Short Current condition and load is removed or the impedance between VBAT+ and VBAT- is larger than 500K~ and $V_{CSI} < V_{OI1}$, M1 is to be turned on and back to normal condition.

Note: when a battery is connected to an IC for the first time, the IC may not enter the normal condition (not dischargeable condition). If this occurs, set the CSI pin voltage equal to the V_{SS} voltage (short the CSI and V_{SS} pins or connect a charger) to enter the normal condition.

TIMING DIAGRAM

Overcharge condition ~ self discharging ~ normal condition

HANGZHOU SILAN MICROELECTRONICS CO.,LTD ————

Silan
Semiconductors
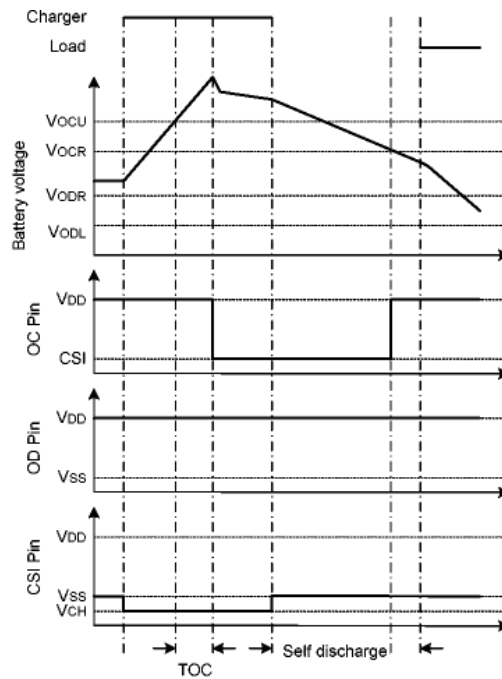
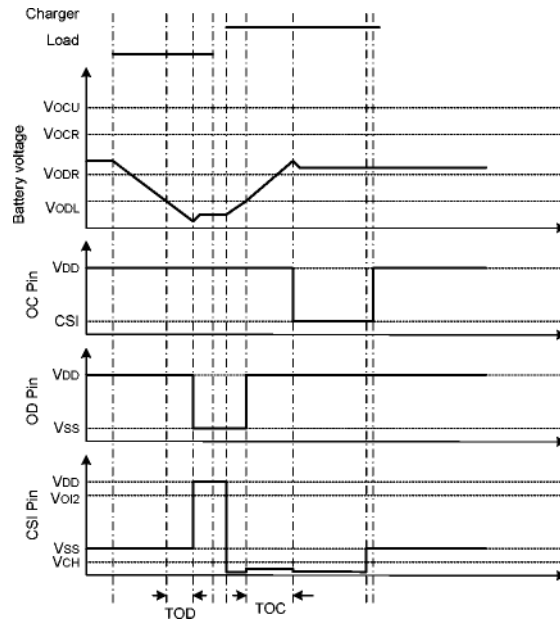**Overcharge condition~ load discharging~ normal condition**
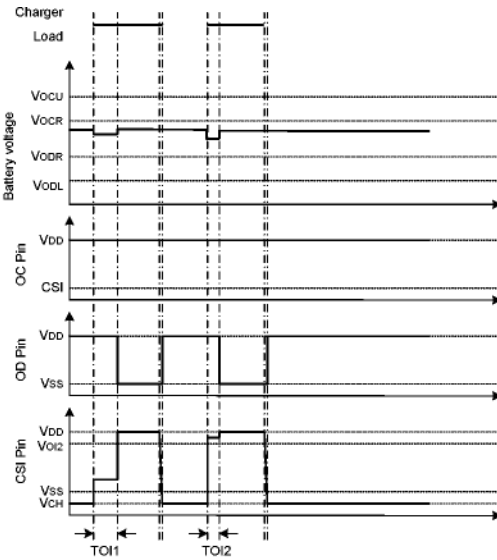**Overcharge condition~ charging by charger~ normal condition**
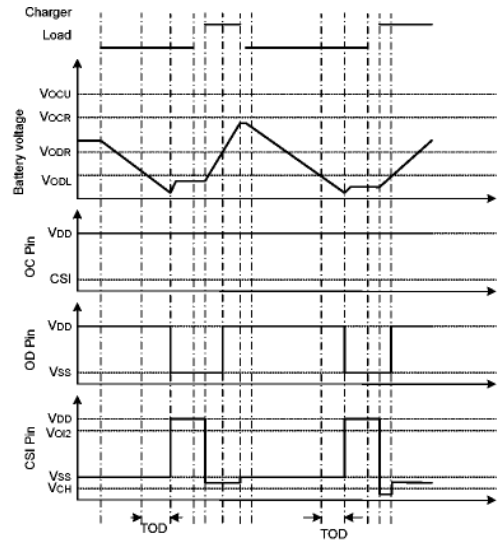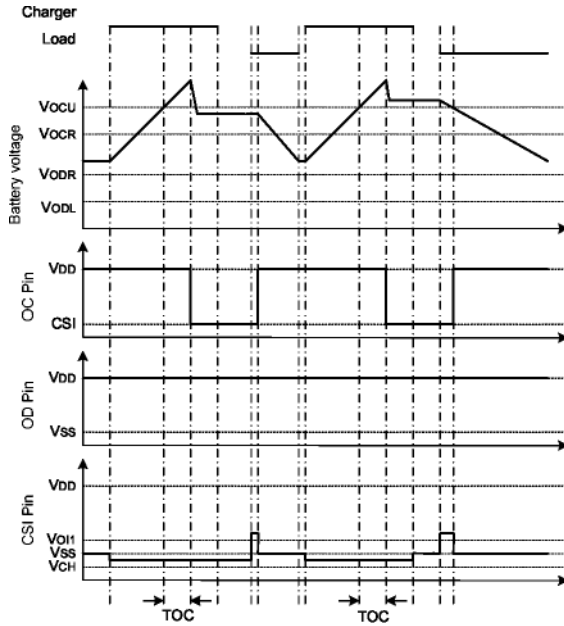
HANGZHOU SILAN MICROELECTRONICS CO.,LTD

SHENZHEN SUN-SHING SCIENCE&TECHNOLGY CO.,LTD
THE SHENZHEN AGENCY OF SILAN   Tel:0755-26221076
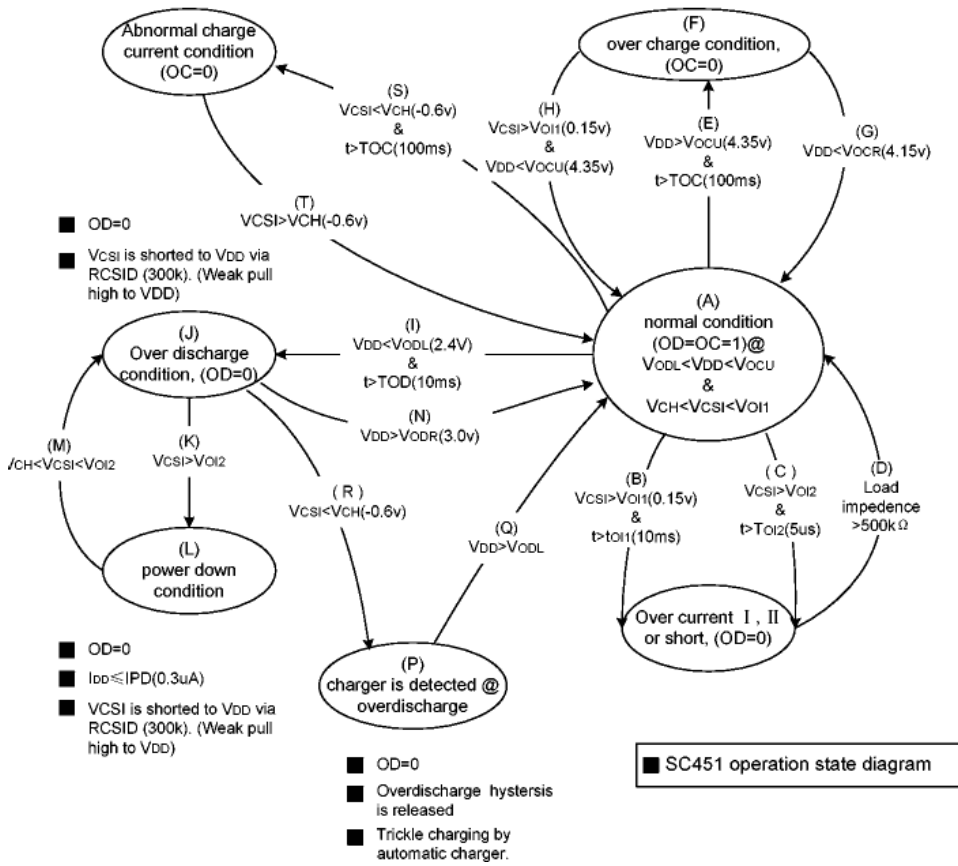
Overcharge condition~ abnormal condition~ normal condition
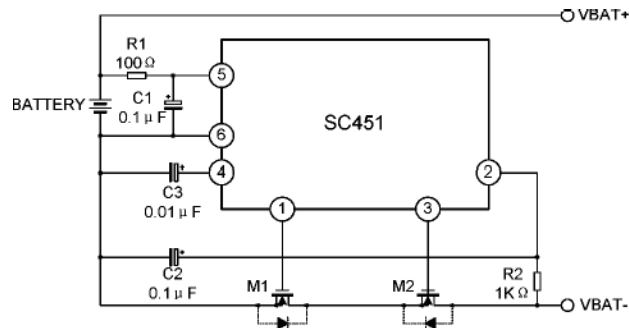

Over current condition~ normal condition

HANGZHOU SILAN MICROELECTRONICS CO.,LTD

E DIAGRAM OF OPERATION

(F) over charge condition, (OC=0)

(S) $V_{CSI}<V_{CH}(-0.6v)$ & t>TOC(100ms)

Abnormal charge current condition (OC=0)

(H) $V_{CSI}>V_{OI1}(0.15v)$ & $V_{DD}<V_{OCU}(4.35v)$

(E) $V_{DD}>V_{OCU}(4.35v)$ & t>TOC(100ms)

(G) $V_{DD}<V_{OCR}(4.15v)$

(T) $V_{CSI}>V_{CH}(-0.6v)$

■ OD=0
■ V_{CSI} is shorted to V_{DD} via RCSID (300k). (Weak pull high to VDD)

(J) Over discharge condition, (OD=0)

(I) $V_{DD}<V_{ODL}(2.4V)$ & t>TOD(10ms)

(A) normal condition (OD=OC=1)@ $V_{ODL}<V_{DD}<V_{OCU}$ & $V_{CH}<V_{CSI}<V_{OI1}$

(N) $V_{DD}>V_{ODR}(3.0v)$

(M) $V_{CH}<V_{CSI}<V_{OI2}$

(K) $V_{CSI}>V_{OI2}$

(R) $V_{CSI}<V_{CH}(-0.6v)$

(Q) $V_{DD}>V_{ODL}$

(B) $V_{CSI}>V_{OI1}(0.15v)$ & t>toI1(10ms)

(C) $V_{CSI}>V_{OI2}$ & t>TOI2(5us)

(D) Load impedence >500kΩ

(L) power down condition

(P) charger is detected @ overdischarge

Over current I , II or short, (OD=0)

■ OD=0
■ $I_{DD} \le IPD(0.3uA)$
■ V_{CSI} is shorted to V_{DD} via RCSID (300k). (Weak pull high to VDD)

■ OD=0
■ Overdischarge hystersis is released
■ Trickle charging by automatic charger.

■ SC451 operation state diagram

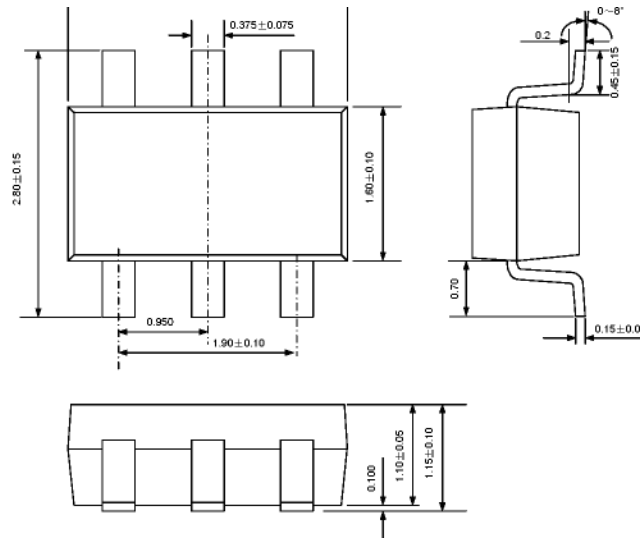## TYPICAL APPLICATION CIRCUITS

PACKAGE OUTLINE

SOT-23-6   UNIT: mm

HANDLING MOS DEVICES:

Electrostatic charges can exist in many things. All of our MOS devices are internally protected against electrostatic

discharge but they can be damaged if the following precautions are not taken:

- Persons at a work bench should be earthed via a wrist strap.

- Equipment cases should be earthed.
- All tools used during assembly, including soldering tools and solder baths, must be earthed.

- MOS devices should be packed for dispatch in antistatic/conductive containers.

SUN-SHING SCIENCE&TECHNOLGY CO.,LTD
(SHENZHEN AGENCY OF SILAN   Tel:0755-26221076

Rev: 1.3   2004.10.13

Attachment Revision History

Data	REV	Description	Page
2003.05.12	1.0	Original	
2003.10.28	1.1	Modify the " ELECTRICAL CHARACTERISTICS"	3
2004.04.20	1.2	Modify the " ELECTRICAL CHARACTERISTICS"	3
2004.10.13	1.3	Modify the " PACKAGE OUTLINE"	9

SUN-SHING SCIENCE&TECHNOLGY CO.,LTD
(SHENZHEN AGENCY OF SILAN   Tel:0755-26221076

Rev: 1.3   2004.10.13