Single Cell Lithium-ion/Lithium-polymer Battery Protection IC

EC9523

General Description

The EC9523 Li-ion/Li-polymer battery protection IC has high accuracy voltage detector and delay time circuit inside.0 V charge function and self-recovery function are available. The operating quiescent current is very low. It is designed to protect 1-cell lithium-ion / lithium polymer rechargeable batteries from damage or degrading life time due to the overcharge, over discharge and charge/discharge over current etc.

Features

- **Overcharge detection voltage 4.25 V to 4.35V, Accuracy ±50 mV**
- **Overcharge release voltage 4.05 V to 4.15V, Accuracy ±50 mV**
- **Overdischarge detection voltage 2.3 to 2.5V, Accuracy ±100 mV**
- **Overdischarge release voltage 2.9 to 3.1V, Accuracy ± 100 mV**
- **Ultra-low operating current 2.5μA@Vcc=3.9V**
- **Self-recovery function available**
- **Overcurrent protection and load short protection**
- **0V charge function available**
- **Over charge current protection available**

Applications

- **Single cell Lithium-ion/Lithium polymer rechargeable battery pack.**
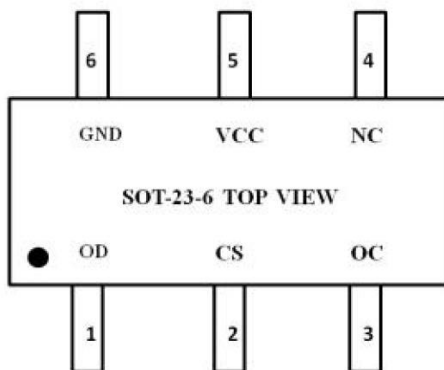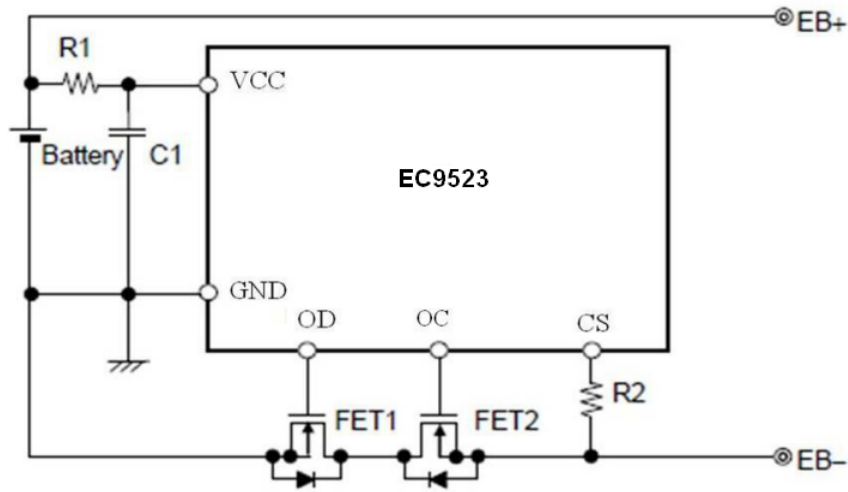
Pin Configuration & Pin Function

Table 1: Pin definition and description for SOT23-6

No	Pin	Function
1	OD	Connection of charge MOSFET gate
2	CS	Pin for voltage and current detection
3	OC	Connection of discharge MOSFET gate
4	NC	No connection
5	VCC	Power supply
6	GND	Ground

Application Circuit

Components	Function	Min	Typ	Max	Unit
R1	RC Filter		100	1K	Ω
C1	RC Filter	0.022	0.1	1.0	uF
R2	Limit transient current	300	1K	2K	Ω
FET1 & FET2	NMOS Discharge/Charge control switch				

Function Diagram

Ordering Information

EC9523NN XX X

R : Tape & Reel

Package Type :
B3=SOT23-6L
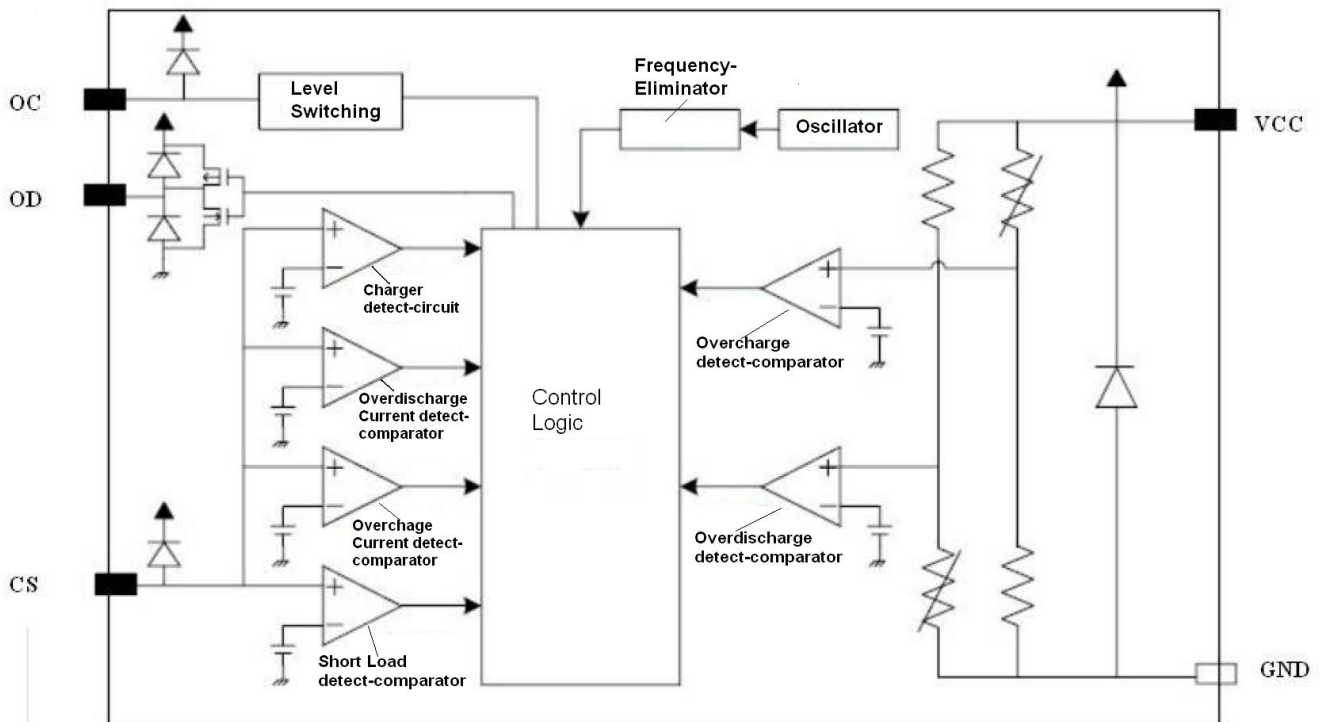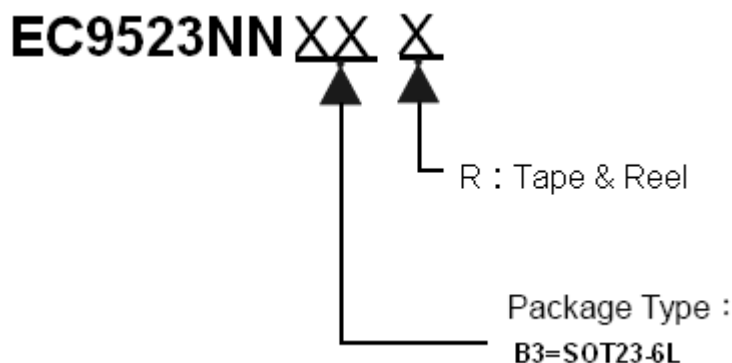
Package	Part Number	Marking	Marking Information
SOT23-6L	EC9523NNB3R	9523 LLLL	LLLL：Lot No

Part No	Overcharge detection voltage [VOCP] (V)	Overcharge release voltage [VOCR] (V)	Overdischarge detection voltage [VODP] (V)	Overdischarge release voltage [VODR] (V)	Overcurrent detection voltage [VOIP/VOI1] (V)	Short detection voltage [VSIP/VIO2] (V)	Charge overcurrent detection voltage [VCOIP] (V)
EC9523NNB3R	4.3 +/- 0.05	4.1 +/- 0.05	2.4 +/- 0.1	3.0 +/- 0.1	0.15 +/- 0.03	0.85 +/- 0.3	-0.10 +/- 0.05

Absolute Maximum Rating

Table 2

(Ta = +25°C unless otherwise specified)

Item	Symbol	Applied Pin	Absolute Maximum Rating	Unit
Input voltage between VCC pin and GND pin	VDS	VCC	VSS − 0.3 to VSS + 10	V
CS pin input voltage	VCS	CS	VCC − 10 to VCC + 0.3	V
OC pin output voltage	VOC	OC	VCC − 10 to VCC + 0.3	V
OD pin output voltage	VOD	OD	VSS − 0.3 to VCC + 0.3 V	V
Operation ambient temperature	Topr		−40 to +85	°C
Storage temperature	Tstg		−55 to +125	°C

Electrical Characteristics

T_A = 25°C; unless otherwise specified.

Parameter	Test condition	Symbol	Min	Typ	Max	Unit
Current consumption	VCC=3.9 V	Icc		2.5	6.0	uA
Current @ Powerdown with self-recovery	VCC=2 V	IPD		2		uA
Overcharge Protection voltage		VOCP	4.25	4.30	4.35	V
Overcharge release voltage		VODP	4.05	4.1	4.15	V
Overdischarge protection voltage		VODP	2.3	2.4	2.5	V
Overdischarge release voltage		VODR	2.9	3.0	3.1	V
Discharge overcurrent detection voltage		VOIP (VOI1)	0.12	0.15	0.18	V
Charge overcurrent detection voltage		VCOIP	-0.15	-0.10	-0.05	V
Short detection voltage		VSIP (VOI2)	0.55	0.85	1.15	V
0V-charge charger voltage		V0CHA		1.2		V
Overcharge Protection delay		TOC		100	200	ms
Overdischarge protection delay		TOD		25	50	ms
Discharge overcurrent delay		TOIP		12	25	ms
charge overcurrent delay		TCOIP		12	25	ms
Short delay time		TSIP		50	500	us

Description of operation

1.Overcharge protection

When the battery voltage becomes higher than VOCP and the detection continues for TOCP (overcharge protection delay time) or longer, EC9523 turns the charging control MOSFET off to stop charging. This protection is called the overcharge protection. The overcharge status is released in the following two cases.

(1) The voltage of battery is lower than VOCR (the release voltage of overcharge protection) through self-discharge.

(2) The voltage of battery is lower than VOCP but higher than VOCR, if the load is connected, overcharge protection status is also released.

When the voltage of battery is higher than VOCP, the overcharge protection will not be released even a load is connected with the battery pack.

2.Overdischarge protection

When the battery voltage falls below overdischarge detection voltage (VODP) during discharging in the normal status and the detection continues for the TODP (overdischarge protection delay time) or longer, EC9523 turns the discharging control MOSFET off to stop discharging. This condition is called the overdischarge protection. When the battery voltage is charged to over than VODR (overdischarge release voltage) by charger, the overdischarge protection is released.

3.Overcurrent protection

When the battery discharge current is over than the specified current, the OD pin will be turn off to stop the discharge operation. The discharge current is sensed by monitoring the voltage on the CS pin. Once the voltage on the CS pin is higher than the VOIP(overcurrent protection voltage) and the detection continues for the TOIP(overcrrent protection delay time) or longer, the MOSFET connected with the OD pin will be shutdown. The overcurrent protection returns to the normal condition when the load is removed or the impendence between EB+and EB- is larger than 500 KΩ.

4.Charge Overcurrent protection

When the charge current provided by charger is over than the specified current, the OC pin will be turn off to stop charge operation. The charge current is sensed by monitoring the voltage on the CS pin. Once the voltage on the CS pin is lower than the VCOIP (charge overcurrent protection voltage) and the detection continues for TCOIP(charge overcurrent protection delay time), the OC pin will become low to turn off the external MOSFET. When the voltage on the CS pin is higher than the VCOIP, the charge overcurrent protection will be released.

5.0V battery charge function

This function is used to recharge a connected battery whose voltage is 0 V due to self-discharge. When V0CHA (the 0 V battery charge starting charger voltage) or a higher voltage is applied between the EB+ and EB− pins by connecting a charger, the charging control MOSFET gate is fixed to the VDD potential. When the voltage between the gate and source of the charging control MOSFET becomes equal to or higher than the threshold voltage due to the charger voltage, the charging control MOSFET is turned on to start charging. At this time, the discharging control MOSFET is off and the charging current flows through the internal parasitic diode in the discharging control MOSFET. When the battery voltage becomes higher than VODR, EC9523 enters the normal status.

6.Self-recovery function

EC9523 still operates even discharge protection occurred. Once the battery voltage returns to over than VODR ,the discharge protection will be released and the IC (EC9523)   will enter the normal status.
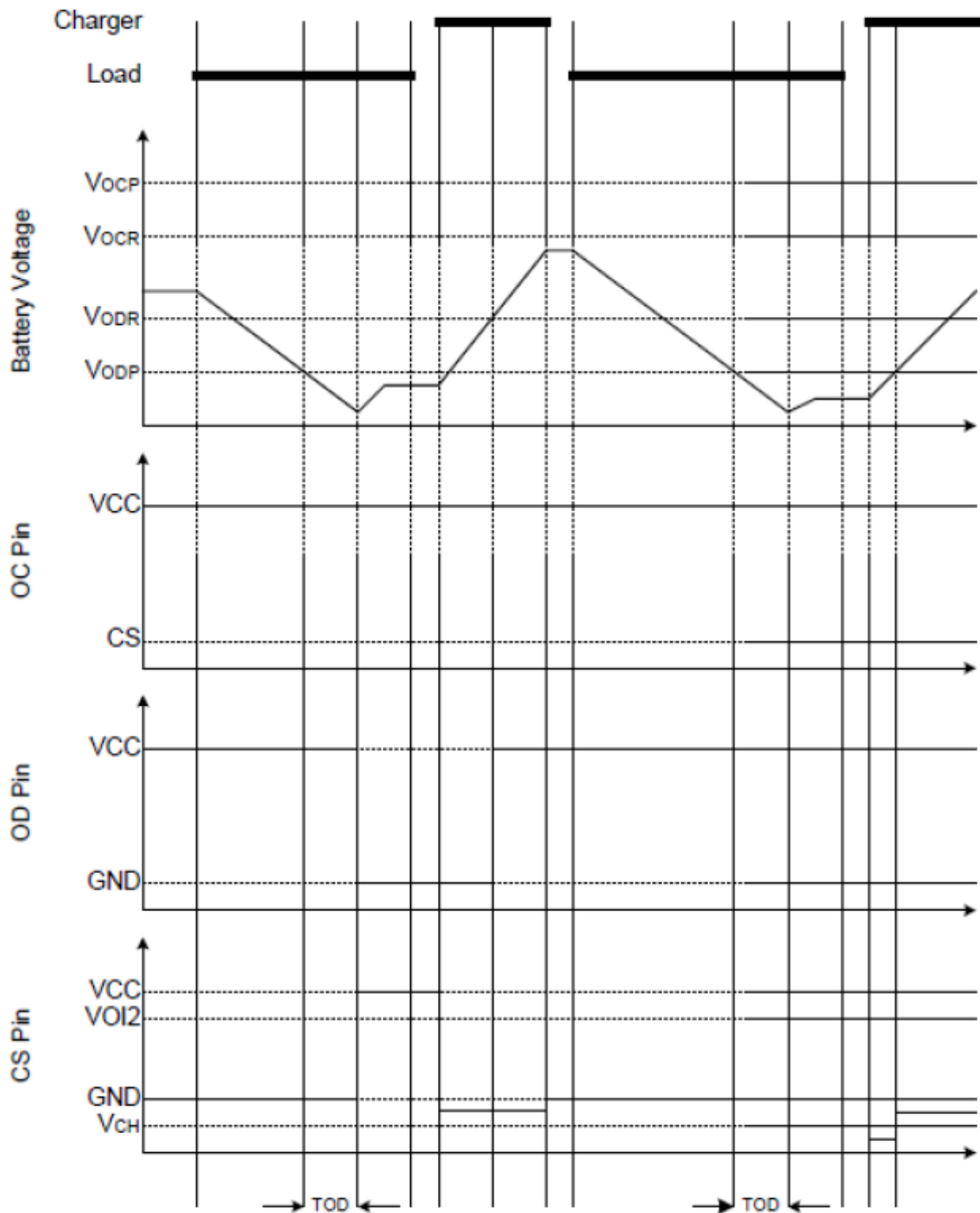
Timing Diagram

1. Overcharge protection
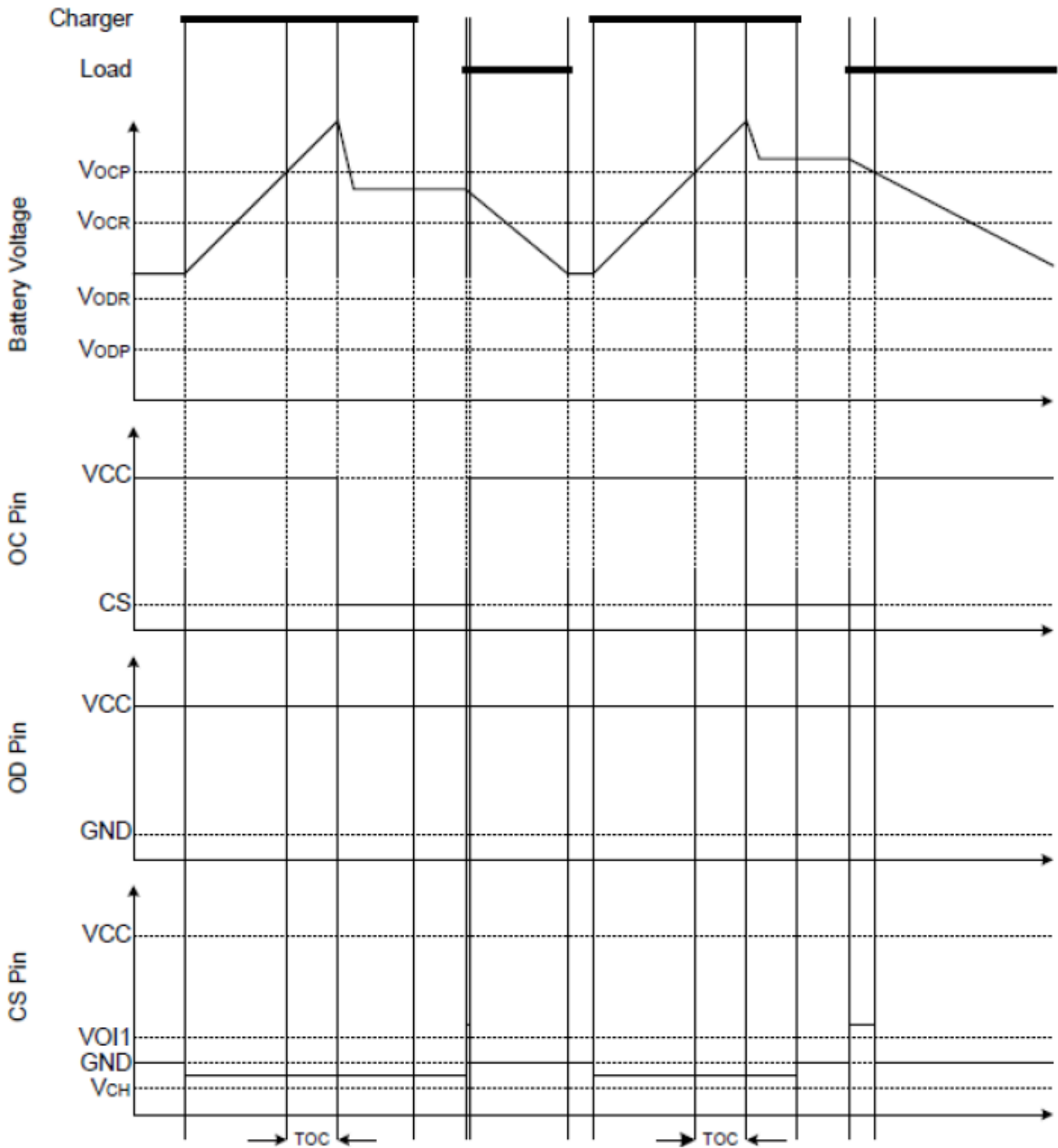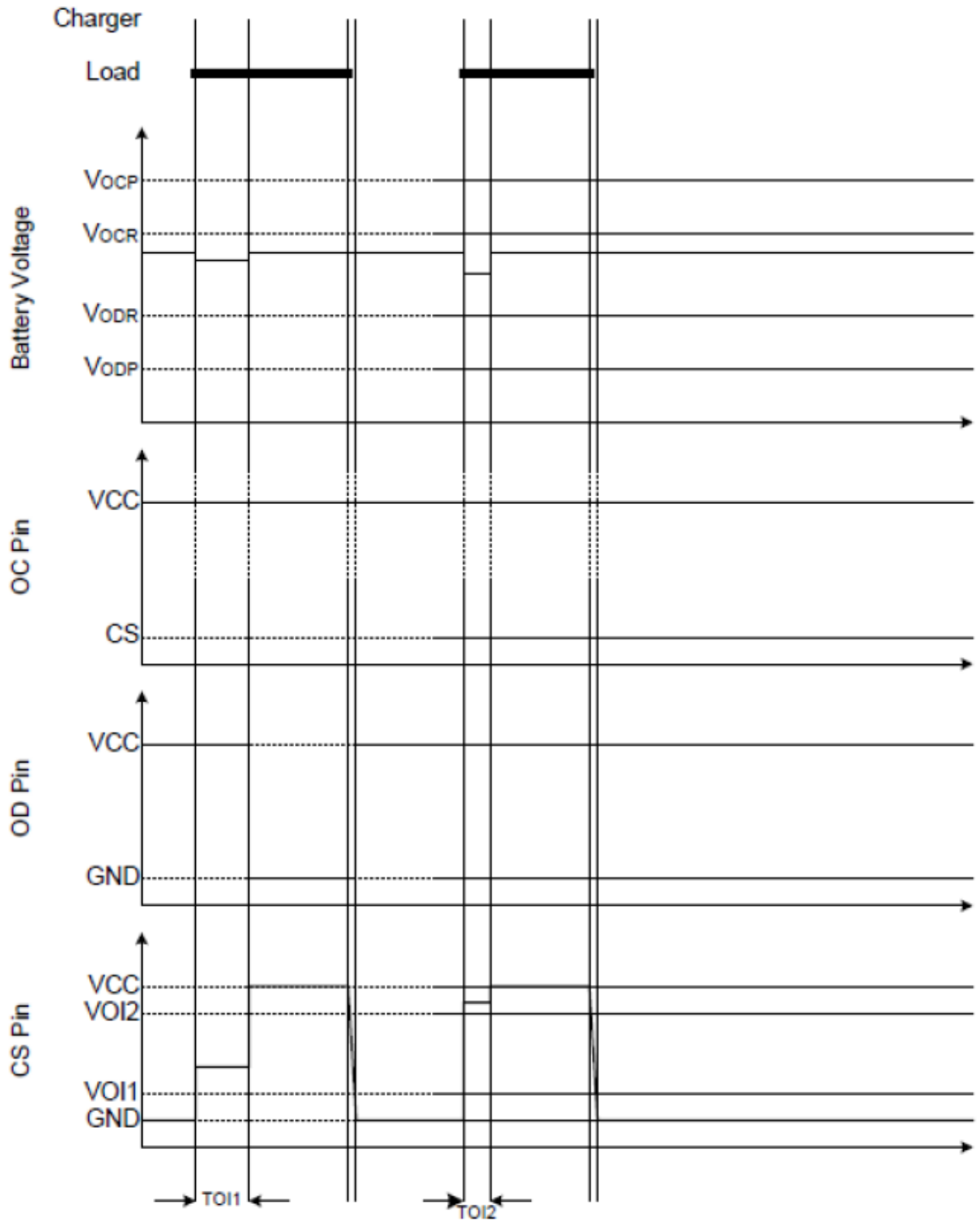

● **TOC-overcharge delay time**

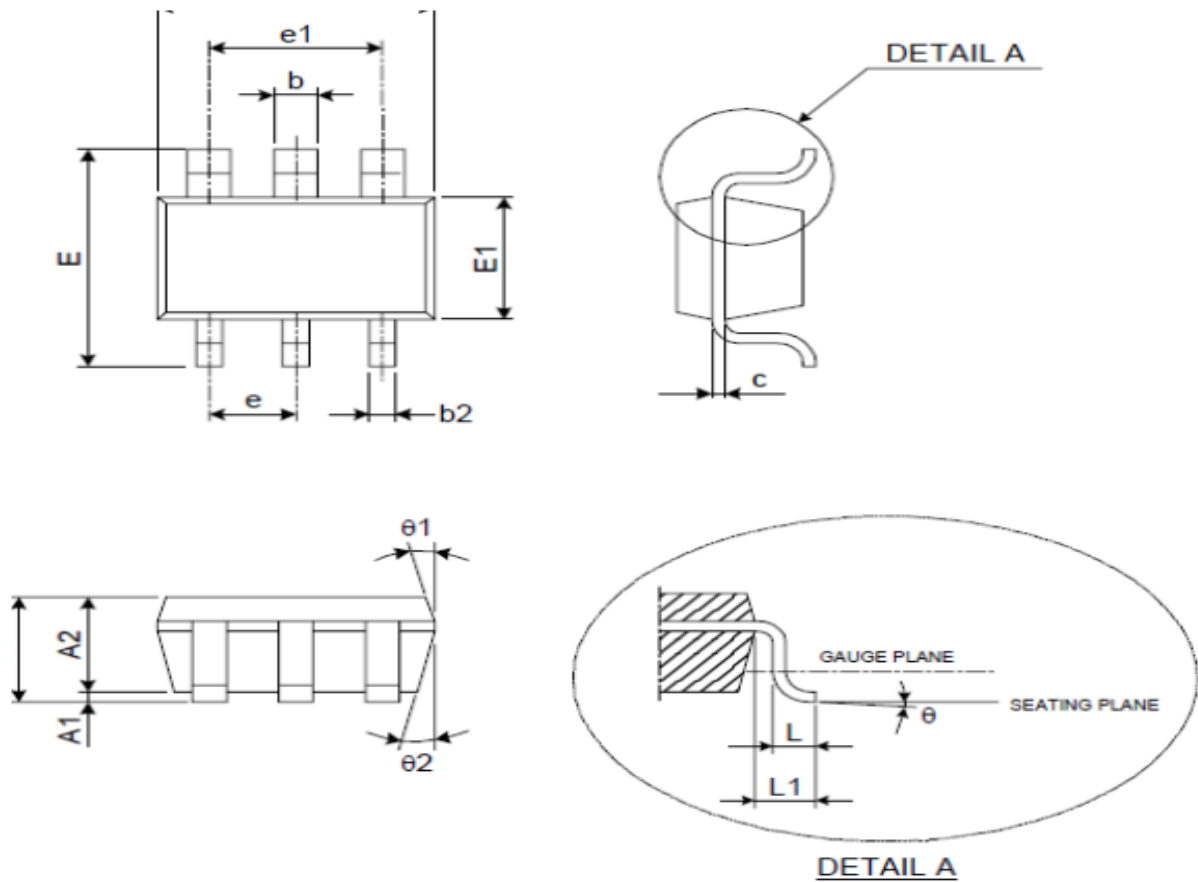## 2. Over discharge Protection

- **TOD-overdischarge delay time**

3.Overcharge Protection

- **TOI1-over current protection delay time**
- **TOI2-short protection delay time**

Package Outline

SOT23-6L

Unit : mm

SYMBOL	MIN.	TYP.	MAX.
A	1.05	-	1.35
A1	0.05	-	0.15
A2	1.00	1.10	1.20
b	0.40	-	0.55
b2	0.25	-	0.40
c	0.08	-	0.20
D	2.70	2.90	3.00
E	2.60	2.80	3.00
E1	1.50	1.60	1.70
L	0.35	0.45	0.55
L1	0.60 REF.		
e	0.95 BSC.		
e1	1.90 BSC.		
θ	0°	5°	10°
θ1	3°	5°	7°
θ2	6°	8°	10°