One Cell Lithium-ion/Polymer Battery Protection IC

• Features

Reduction in Board Size due to Miniature Package SOT-23-6.

Ultra-Low Quiescent Current at 3μA (Vcc=3.9V).

Ultra-Low Power-Down Current at 0.1μA (Vcc=2.0V).

Precision Overcharge Protection Voltage 4.3V ± 50mV

Auto Overdischarge recovery function

0V battery charge function "available" / "unavailable" are selectable

Load Detection Function during Overcharge

Two Detection Levels for Overcurrent

Delay times are generated by internal circuits.

No external capacitors required.

• General Description

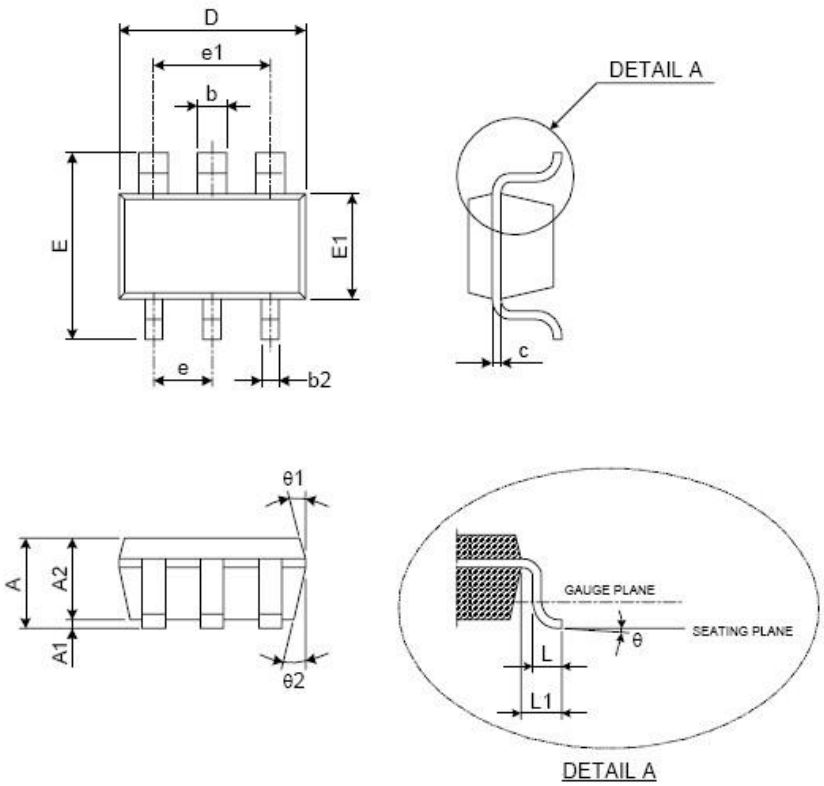
The SSCDW01 battery protection IC is designed to protect lithium-ion/polymer battery from damage or degrading the lifetime due to overcharge, overdischarge, and/or overcurrent for one-cell lithium-ion/polymer battery powered systems, such as cellular phones.

The ultra-small package and less required external components make it ideal to integrate the SSCDW01 into the limited space of battery pack. The accurate ±50mV overcharging detection voltage ensures safe and full utilization charging. The very low standby current drains little current from the cell while in storage.

• Applications

Protection IC for One-Cell Lithium-Ion / Lithium-Polymer Battery Pack

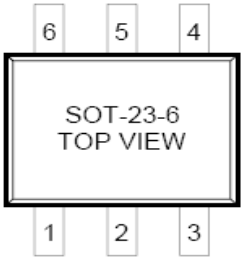
• Package Information

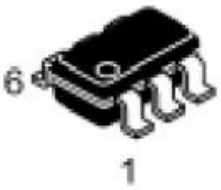


Unit : mm

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°

- **PIN CONFIGURATION**

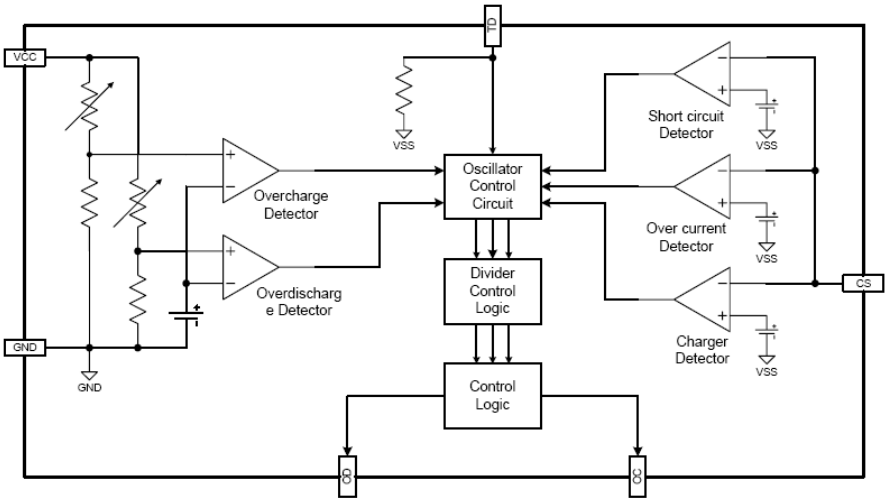




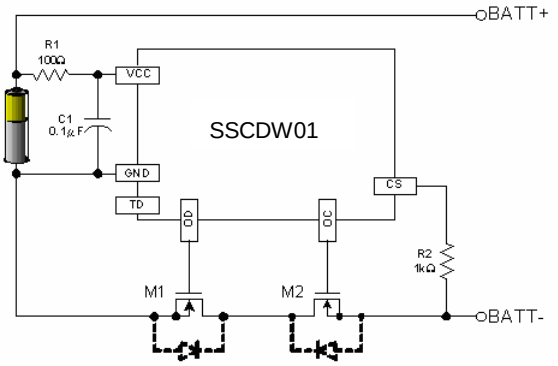
- **PIN ASSIGNMENT**

Pin No.	Symbol	Description
1	OD	MOSFET gate connection pin for discharge control
2	CS	Input pin for current sense, charger detect
3	OC	MOSFET gate connection pin for charge control
4	TD	Test pin for reduce delay time
5	VCC	Power supply, through a resistor (R1)
6	GND	Ground pin

- **Functional Block Diagram**



- **Typical Application Circuit**



- **Absolute Maximum Ratings** @T_A = 25°C unless otherwise noted

Parameter	Symbol	Ratings	Unit
Input voltage between VCC and GND *	VCC	GND-0.3 to GND+10	V
OC output pin voltage	VOC	VCC -24 to VCC +0.3	V
OD output pin voltage	VOD	GND-0.3 to VCC +0.3	V
CS input pin voltage	VCS	VCC -24 to VCC +0.3	V
Operating Temperature Range	TOP	-40 to +85	°C
Storage Temperature Range	TST	-40 to +125	°C

Note: SSCDW01 contains a circuit that will protect it from static discharge; but please take special care that no excessive static electricity or voltage which exceeds the limit of the protection circuit will be applied to it.

- **Electrical Characteristics** (Ta=25°C unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
ICC	Supply Current	VCC=3.9V		3	6	μA
IoD	Overdischarge Current	VCC=2.0V	0.16		0.5	μA
IPD	Power-Down Current	VCC=2.0V			0.1	μA
VOCP	Overcharge Protection Voltage		4.25	4.3	4.35	V
VOCR	Overcharge Release Voltage		4.05	4.1	4.15	V
VODP	Overdischarge Protection Voltage		2.3	2.4	2.5	V
VODR	Overdischarge Release Voltage		2.9	3.0	3.1	V
VOIP(VOI1)	Overcurrent Protection Voltage		120	150	180	mV
VOIP(VOI2)	Short Current Protection Voltage	VCC=3.6V	0.8	1.35	1.7	V
TOC	Overcharge Delay Time			80	200	ms
TOD	Overdischarge Delay Time	VCC=3.6V to 2.0V		40	100	ms
TOI1	Overcurrent Delay Time (1)	VCC=3.6V		10	20	ms
TOI2	Overcurrent Delay Time (2)	VCC=3.6V			500	us
VCHA	Charger Detection Threshold Voltage		-1.2	-0.7	-0.2	V
VDH	OD Pin Output “H” Voltage		VCC-0.1	VCC-0.02		V
VDL	OD Pin Output “L” Voltage			0.1	0.5	V
VCH	OC Pin Output “H” Voltage		VCC-0.1	VCC-0.02		V
VCL	OC Pin Output “L” Voltage			0.1	0.5	V
V0CH	0V battery charge staring charge voltage	0V Battery charging Function “Available”	1.2			V
V0IN	0V battery charge inhibition charge voltage	0V Battery charging Function “unavailable”			0.5	V

• Description of Operation

1. Overcharge Protection

When the voltage of the battery cell exceeds the overcharge protection voltage (VOCP) beyond the overcharge delay time (TOC) period, charging is inhibited by turning off of the charge control MOSFET.

The overcharge condition is released in two cases:

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

2) The voltage of the battery cell falls below the overcharge protection voltage (VOCP) and a load is connected.

When the battery voltage is above VOCP, the overcharge condition will not release even a load is connected to the pack.

2. Overdischarge Protection

When the voltage of the battery cell goes below the overdischarge protection voltage (VODP) beyond the overdischarge delay time (TOD) period, discharging is inhibited by turning off the discharge control MOSFET. The default of overdischarge delay time is 10ms. Inhibition of discharging is immediately released when the voltage of the battery cell becomes higher than overdischarge release voltage (VODR) through charging.

3. Overcurrent Protection

In normal mode, the SSCDW01 continuously monitors the discharge current by sensing the voltage of CS pin. If the voltage of CS pin exceeds the overcurrent protection voltage (VOIP) beyond the overcurrent delay time (TOI1) period, the overcurrent protection circuit operates and discharging is inhibited by turning off the discharge control MOSFET. The overcurrent condition returns to the normal mode when the load is released or the impedance between BATT+ and BATT- is larger than 500kΩ. The SSCDW01 provides two overcurrent detection levels (0.15V and 1.35V) with two overcurrent delay time (TOI1 and TOI2) corresponding to each overcurrent detection level.

4. Charge Detection after Overdischarge

When overdischarge occurs, the discharge control MOSFET turns off and discharging is inhibited. However, charging is still permitted through the parasitic diode of MOSFET. Once the charger is connected to the battery pack, the SSCDW01 immediately turns on all the timing generation and detection circuitry. Charging progress is sensed if the voltage between CS and GND is below charge detection threshold voltage (VCH).

5. Power-Down after Overdischarge

When overdischarge occurs, the SSCDW01 will enter into power-down mode, turning off all the timing generation and detection circuitry to reduce the quiescent current to 0.1 μ A (VCC=2.0V). At the same time, the CS pin is pull-up to VCC through an internal resistor.

6. products with Auto Overdischarge recovery Function

When the battery voltage falls below than the overdischarge detection voltage during diacharging in the normal status and the detection continues longer than the overdiacharge detection delay time,the SSCDW01 series will turn the discharging control MOSFET off so as to stop discharging. This condition is called the overdischarge status.

The overdischarge status will be released by three cases:

1) When CS pin voltage is equal to or lower than the charger detection voltage(VCHA) by charging and the VDD pin voltage is higher than overdiacharge detection voltage(VDL)

2) When CS pin voltage is equal to or higher than the charger detection voltage(VCHA) by charging and the VDD pin voltage is higher than overdiacharge release voltage(VDR)

3) Without connecting a charger, if VDD pin voltage is higher than overdiacharge release voltage(VDR), the overdischarge status will be release.

7. 0V Battery charging Function “Available”

This Function is used to recharge a connected battery which voltage is 0V due to self-discharge. When the 0V battery charge starting charger voltage (VOCH) or a higher voltage is applied between PB+ and PB- pins by connecting a charger, the charging control MOSFET

gate is fixed to the VDD pin voltage.

When the voltage between the gate and the source of the charging control MOSFET becomes equal to or higher than the turn on voltage due to the charger voltage, the charging control MOSFET is turned on to initiate 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 equal to or higher than overdischarge voltage (VDL) the SSCDW01 series will enter into the normal status.

Caution

(1) Some battery providers do not recommend charging for a completely self-discharged battery. Please ask the battery provider to determine whether to enable or prohibit the 0V battery charging function.

(2) The 0V battery charge function has higher priority than the charge overcurrent detection function. Consequently, a product in which use of the 0V battery charging function is enabled to forcibly charge a battery and the charge current cannot be detected when the battery voltage is lower than overdischarge detection voltage (VDL).

8. 0V Battery Charging Function "Unavailable"

When a battery that is internally short-circuited (0V battery) is connected, the unavailable 0V charging function will prohibit recharging. When the battery voltage equals to the 0V battery charge inhibition battery voltage (V0IN) or lower, the charging control MOSFET gate is fixed to the PB- pin voltage to prohibit charging. When the battery voltage equals to the 0V battery charge inhibition battery voltage (V0IN) or higher, charging can be implemented.

Caution

(1) Some battery providers do not recommend charging for a completely self-discharged battery. Please ask the battery provider to determine whether to enable or prohibit the 0V battery charging function.

(2) The 0V battery charge function has higher priority than the charge overcurrent detection function. Consequently, a product in which use of the 0V battery charging function is enabled to forcibly charge a battery and the charge current cannot be detected when the battery voltage is lower than overdischarge detection voltage (VDL).

• Design Guide

1. Selection of External Control MOSFET

Because the overcurrent protection voltage is preset, the threshold current for overcurrent detection is determined by the turn-on resistance of the charge and discharge control MOSFETs. The turn-on resistance of the external control MOSFETs can be determined by the equation: RON=VOIP/ (2 x IT) (IT is the overcurrent threshold current). For example, if the overcurrent threshold current IT is designed to be 3A, the turn-on resistance of the external control MOSFET must be 25mΩ. Be aware that turn-on resistance of the MOSFET changes with temperature variation due to heat dissipation. It changes with the voltage between gate and source as well. (Turn-on resistance of MOSFET increases as the voltage between gate and source decreases). As the turn-on resistance of the external MOSFET changes, the design of the overcurrent threshold current changes accordingly.

2. Suppressing the Ripple and Disturbance from Charger

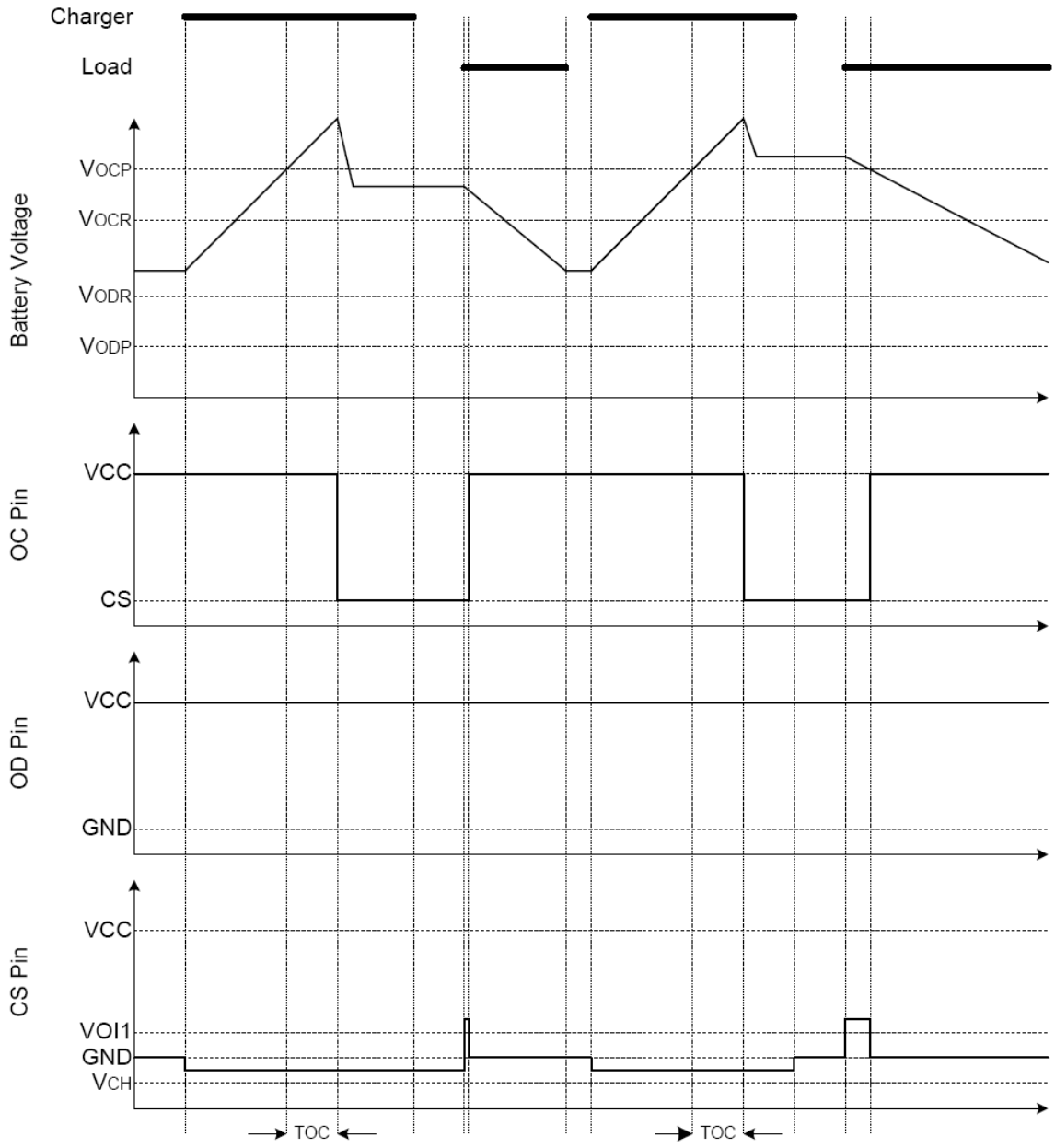
To suppress the ripple and disturbance from charger, connecting R1 and C1 to VCC is recommended.

3. Protection the CS pin

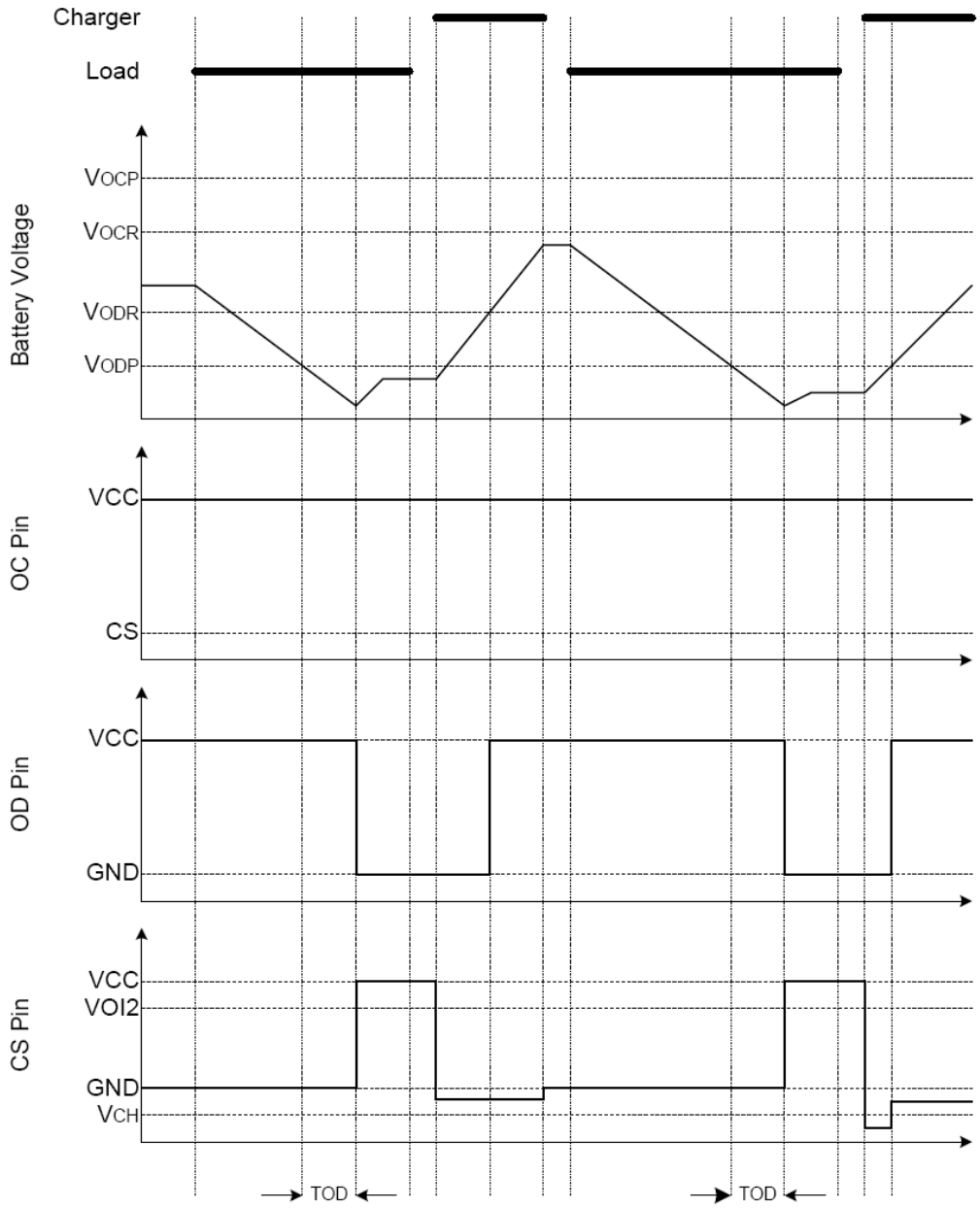
R2 is used for latch-up protection when charger is connected under overdischarge condition and overstress protection at reverse connecting of a charger.

- **Timing Diagram**

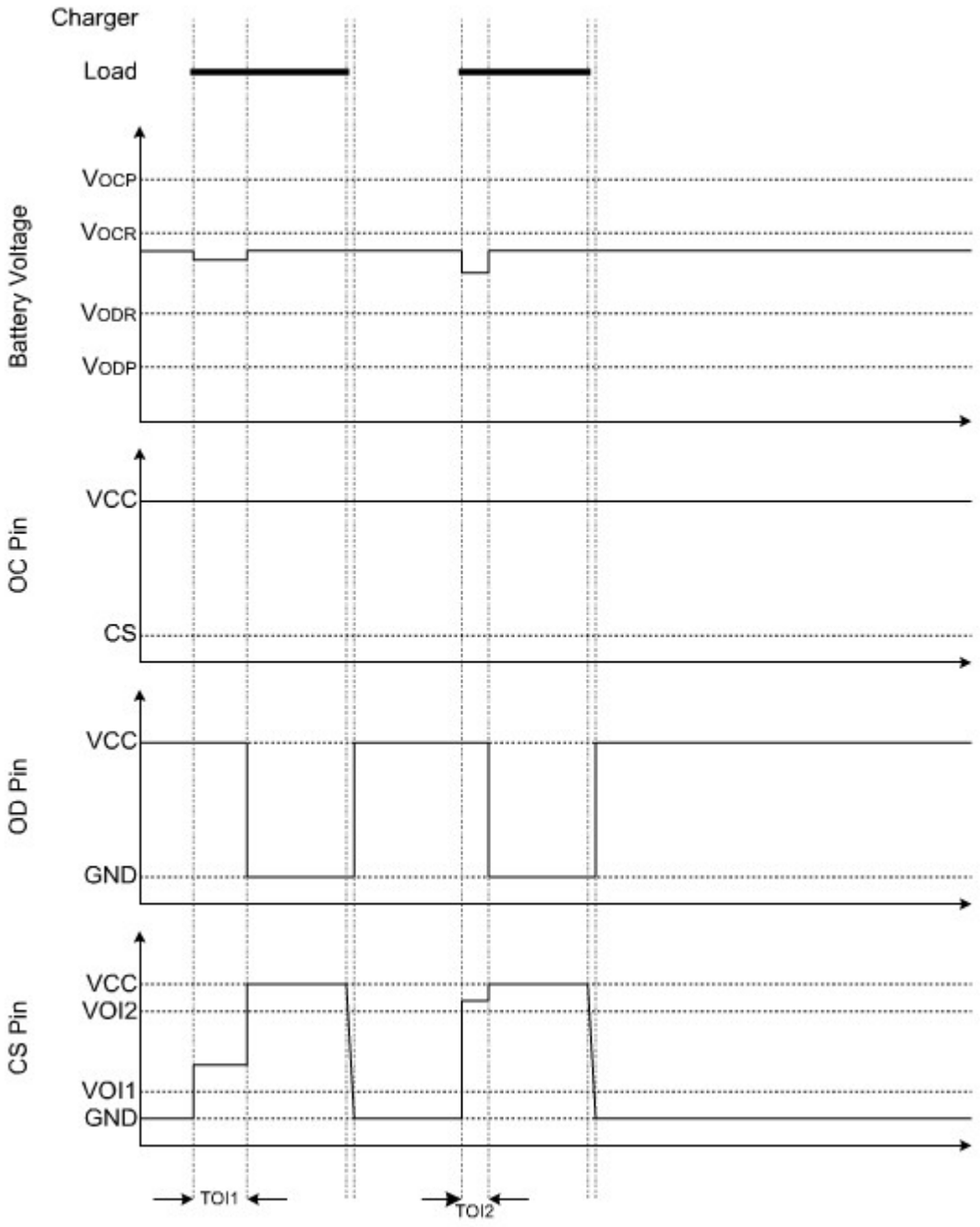
1. Overcharge Condition 、 Load Discharging 、 Normal Condition



2. Overdischarge Condition 、 Charging by a Charger 、 Normal Condition



3.overcurrent condition normal condition



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