



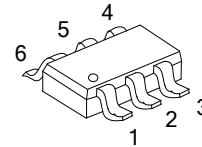
# LITHIUM-ION/POLYMER BATTERY PROTECTION IC

### DESCRIPTION

UTC **UB242** is a series of lithium-ion / lithium-polymer rechargeable battery protection ICs incorporating high accuracy voltage detection circuits and delay circuits.

UTC **UB242** is suitable for protection of single cell lithium-ion / lithium polymer battery packs from overcharge, over discharge and over current.

The ultra-small package and less required external components make it ideal to integrate the UTC **UB242** into the limited space of battery pack.



SOT-26

### FEATURES

- \* Wide supply voltage range:  $V_{DD}=1.8V\sim 6.5V$
- \* Ultra-low quiescent current:  $I_{DD}=3.0\mu A (V_{DD}=3.5V)$
- \* Ultra-low power-down current:  $I_{PD}=0.2\mu A (V_{DD}=2.0V)$
- \* Overcharge detection voltage:  $V_{OCU}=4.200V\sim 4.400V$
- \* Overcharge release voltage:  $V_{OCR}=4.005V\sim 4.225V$
- \* Over discharge detection voltage :  $V_{ODL}=2.15V\sim 3.00V$
- \* Over discharge release voltage:  $V_{ODR}=2.32V\sim 3.10V$
- \* Over current detection voltage:  $V_{OI1}=0.10V\sim 0.20V$
- \* Short circuit detection voltage:  $V_{OI2}=1.35V$  (Fixed)
- \* Charger detection voltage:  $V_{CH}=-0.7V$
- Reset resistance for over current protection:  $R_{SHORT} > 500k\Omega$
- \* Delay times are generated by an internal circuit.  
(External capacitors are unnecessary.)

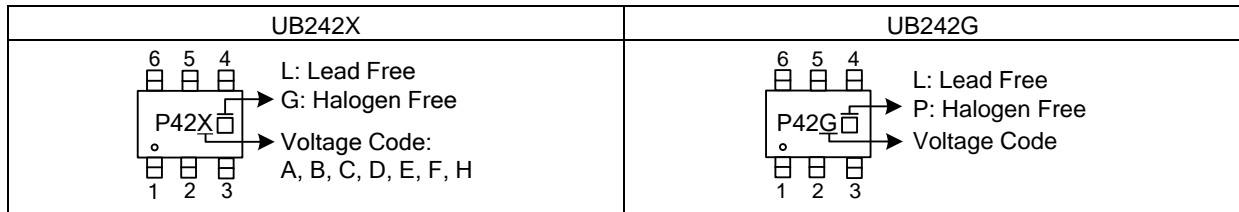
### ORDERING INFORMATION

Ordering Number		Package	Packing
Lead Free	Halogen Free		
UB242XL-AG6-R	UB242XG-AG6-R	SOT-26	Tape Reel
UB242GL-AG6-R	UB242GP-AG6-R	SOT-26	Tape Reel

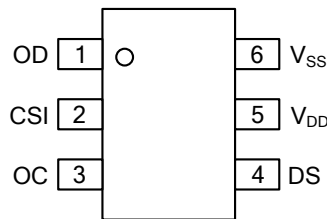
Note: X: Output Voltage, refer SERIAL CODE LIST.

<p>UB242XG-AG6-R</p>	<p>(1) R: Tape Reel  (2) AG6: SOT-26  (3) G : Halogen Free and Lead Free, L: Lead Free  P: Halogen Free and Lead Free For Serial Code G only  (4) refer to SERIAL CODE LIST</p>
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MARKING



PIN CONFIGURATION



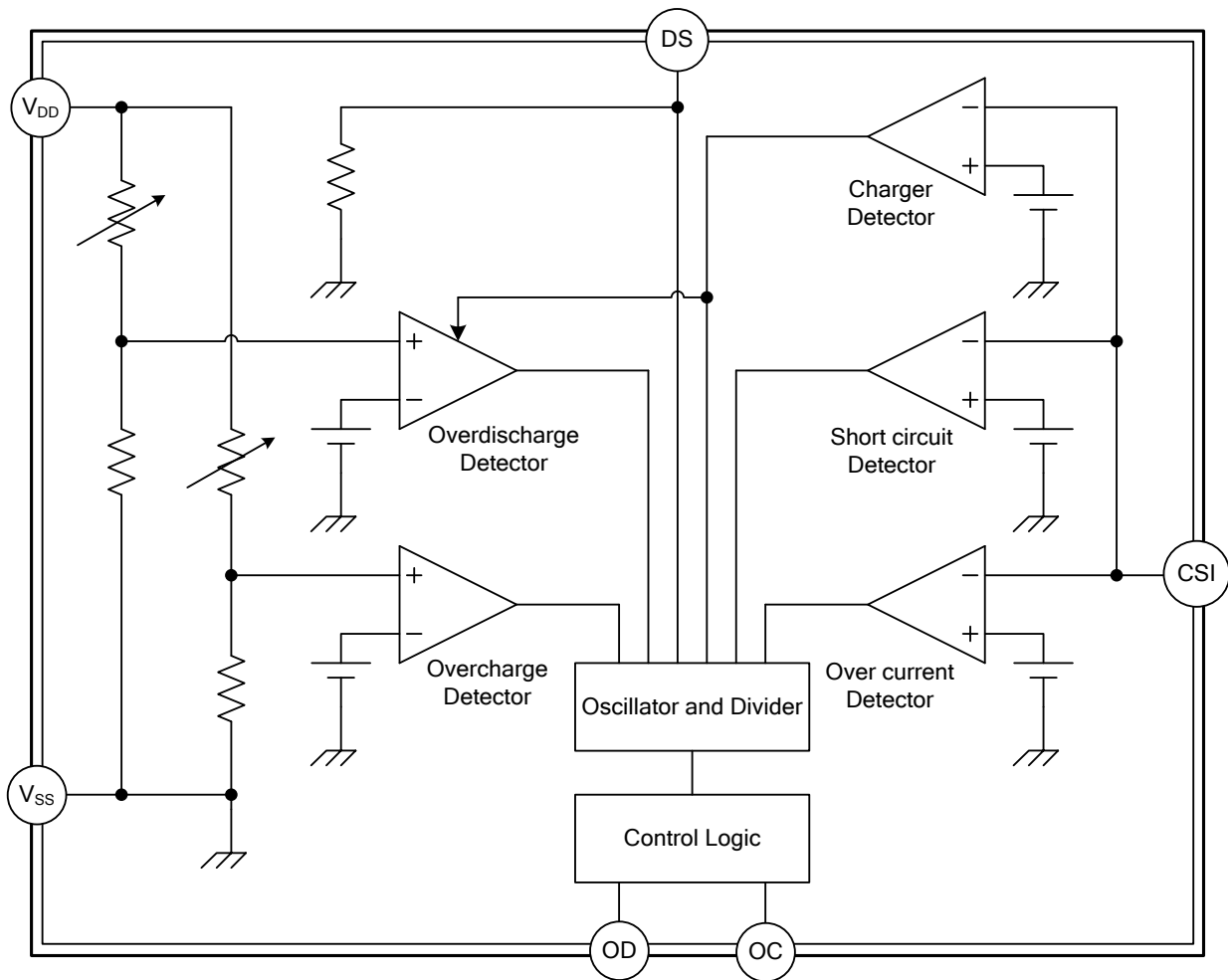
PIN DESCRIPTION

PIN NO	PIN NAME	DESCRIPTION
1	OD	For discharge control: FET gate connection pin
2	CSI	For current sense Input pin, and charge detect
3	OC	For charge control :FET gate connection pin
4	DS	For reduce delay time: test pin
5	V <sub>DD</sub>	Positive power input
6	V <sub>SS</sub>	Negative power input

SERIAL CODE LIST

Model	Code	Overcharge Detection Voltage [V <sub>OCU</sub> ](V)	Overcharge Release Voltage [V <sub>OCR</sub> ](V)	Over discharge Detection Voltage [V <sub>ODL</sub> ](V)	Over discharge Release Voltage [V <sub>ODR</sub> ](V)	Over Current Detection Voltage [V <sub>OIR</sub> ](mV)
UB242	A	4.325±0.050	4.075±0.050	2.500±0.100	2.900±0.100	100±50
	B	4.350±0.050	4.150±0.050	2.300±0.100	3.000±0.100	100±50
	C	4.325±0.050	4.075±0.050	2.500±0.100	2.900±0.100	150±50
	D	4.300±0.050	4.080±0.050	2.500±0.100	2.900±0.100	150±50
	E	4.300±0.050	4.080±0.050	2.500±0.100	2.900±0.100	100±50
	F	4.275±0.050	4.175±0.050	2.300±0.080	2.450±0.080	100±50
	G	4.280±0.050	4.175±0.050	2.900±0.100	3.000±0.100	150±50
	H	4.250±0.050	4.055±0.050	2.250±0.100	2.850±0.100	150±50

■ BLOCK DIAGRAM



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■ **ABSOLUTE MAXIMUM RATING** ( $V_{SS}=0V$ ,  $T_A=25^\circ C$  unless otherwise specified)

PARAMETER	SYMBOL	RATINGS	UNIT
Input Voltage between $V_{DD}$ and $V_{SS}$	$V_{DD}$	$V_{SS} \sim V_{SS}+10$	V
OC Output Pin Voltage	$V_{OC}$	$V_{DD}-24 \sim V_{DD}$	V
OD Output Pin Voltage	$V_{OD}$	$V_{SS} \sim V_{DD}$	V
CSI Input Pin Voltage	$V_{CSI}$	$V_{DD}-24 \sim V_{DD}$	V
DS Input Pin Voltage	$V_{DS}$	$V_{SS} \sim V_{DD}$	V
Operating Temperature	$T_{ORP}$	-40 ~ +85	$^\circ C$
Storage Temperature	$T_{STG}$	-40 ~ +125	$^\circ C$

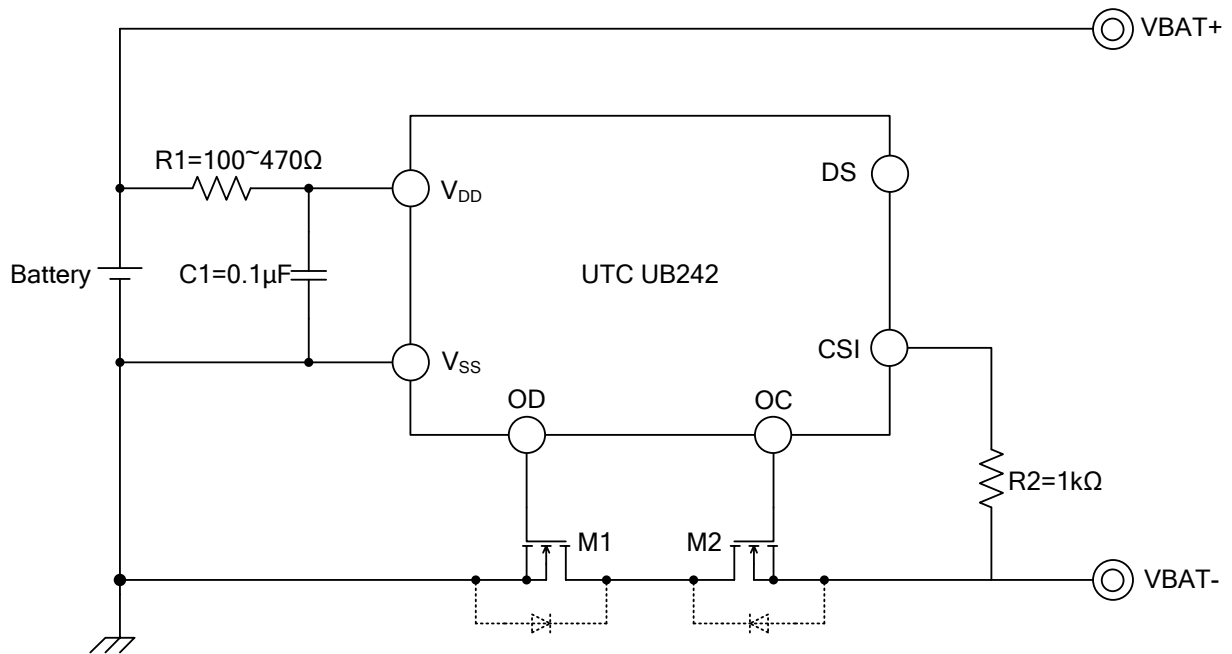
Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

■ **ELECTRICAL CHARACTERISTICS** ( $V_{SS}=0V$ , DS=Floating,  $T_A=25^\circ C$  unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>CURRENT CONSEPTION</b>						
Supply Current	$I_{DD}$	$V_{DD}=3.5V$ , $V_{CSI}=0V$		3.0	8.0	$\mu A$
Power-Down Current	$I_{PD}$	$V_{DD}=V_{CSI}=2.0V$		0.2	0.5	$\mu A$
<b>OPERATING VOLTAGE</b>						
Operating Voltage Between $V_{DD}$ -pin and $V_{SS}$ -pin	$V_{DS1}$	$V_{DD}-V_{SS}$	1.8		6.5	V
Operating Voltage Between $V_{DD}$ -pin and CSI-pin	$V_{DS2}$	$V_{DD}-V_{CSI}$	1.8		20	V
<b>DETECTION VOLTAGE</b>						
Overcharge Detection Voltage	$V_{OCU}$		$V_{OCU}-0.050$	$V_{OCU}$	$V_{OCU}+0.050$	V
Overcharge Release Voltage	$V_{OCR}$		$V_{OCR}-0.050$	$V_{OCR}$	$V_{OCR}+0.050$	V
Overdischarge Detection Voltage	$V_{ODL}$		$V_{ODL}-0.100$	$V_{ODL}$	$V_{ODL}+0.100$	V
Overdischarge Release Voltage	$V_{ODR}$		$V_{ODR}-0.100$	$V_{ODR}$	$V_{ODR}+0.100$	V
Over Current Detection Voltage	$V_{OI1}$	$V_{DD}=3.5V$	$V_{OI1}-0.050$	$V_{OI1}$	$V_{OI1}+0.050$	V
Short Circuit Detection Voltage	$V_{OI2}$	$V_{DD}=3.5V$	1.0	1.35	1.75	V
Charger Detection Voltage	$V_{CH}$	$V_{DD}=3.5V$	-1.2	-0.7	-0.2	V
<b>DELAY TIME</b>						
Overcharge Detection Delay Time	$T_{OC}$	$V_{DD}=3.5V \sim 4.5V$ , DS=Floating	0.7	1.3	1.9	s
		$V_{DD}=3.5V \sim 4.5V$ , $V_{DS}=V_{DD}$	10	20	30	ms
Overdischarge Detection Delay Time	$T_{OD}$	$V_{DD}=3.5V \sim 2.0V$ , DS=Floating	100	180	260	ms
		$V_{DD}=3.5V \sim 2.0V$ , $V_{DS}=V_{DD}$	6	11	17	ms
Over Current Detection Delay Time	$T_{OI1}$	$V_{DD}=3.5V$	5	10	20	ms
Short Circuit Detection Delay Time	$T_{OI2}$	$V_{DD}=3.5V$	5	10	50	$\mu s$
<b>OTHER</b>						
OC Pin Output "H" Voltage	$V_{OH1}$	$V_{DD}=3.5V$ , $I_{OH}=-50\mu A$	$V_{DD}-0.2$	$V_{DD}-0.1$		V
OC Pin Output "L" Voltage	$V_{OL1}$	$V_{DD}=4.5V$ , $V_{CSI}=0V$		0.1	0.5	V
OD Pin Output "H" Voltage	$V_{OH2}$	$V_{DD}=3.5V$ , $I_{OH}=-50\mu A$	$V_{DD}-0.2$	$V_{DD}-0.1$		V
OD Pin Output "L" Voltage	$V_{OL2}$	$V_{DD}=2.0V$ , $I_{OL}=50\mu A$		0.1	0.5	V

Note: If  $V_{DS}=V_{DD}$ , the delay time will be reduced, and the test time for  $V_{OCU}$  or  $V_{ODL}$  will also be reduced.

■ TYPICAL APPLICATION CIRCUIT



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## ■ DESCRIPTION OF OPERATION

### 1. Normal Condition

The voltage of the battery connected between  $V_{DD}$  and  $V_{SS}$  can be monitored by the UTC **UB242**. The voltage difference between CSI and  $V_{SS}$  can sense the charge and discharge scheme. Under this condition:  $V_{ODL} < V_{DD} < V_{OCU}$  and  $V_{CH} < V_{CSI} < V_{OI1}$ , UTC **UB242** will turn on the M2 (charging) and M1 (discharging) control MOSFETs.

### 2. Overcharge Condition

M2 will be turned off under this condition: the battery voltage becomes higher than the overcharge detection voltage ( $V_{OCU}$ ) during normal charging condition through a delay time longer than  $T_{OC}$  (the overcharge detection delay time).

### 3. Release of Overcharge Condition

Two ways to return to normal condition from overcharge condition:

- (1.) Under the condition: the battery is self discharging, and if  $V_{DD} < V_{OCR}$  and  $V_{OI1} > V_{CSI} > V_{CH}$  occurs, UTC **UB242** will be back to normal condition.
- (2.) Connect UTC **UB242** to a load and remove the charger.

### 4. Overdischarge Condition

M1 will be turned off to stop discharging when the battery voltage falls below the overdischarge detection voltage ( $V_{ODL}$ ) during discharging condition and through a delay time longer than  $T_{OD}$  (the overdischarge detection delay time). And then CSI will be pulled up to  $V_{DD}$  through an internal resistance. When  $V_{CSI} > V_{OI2}$ , the chip will enter into power-down mode. In this mode, the current consumption is lower than  $0.1\mu A$ .

### 5. Release of Power-down mode

There are two ways back to normal condition:

- (1.) If  $V_{CSI} < V_{CH}$  (Charger detection), when  $V_{DD} > V_{ODL}$
- (2.) If  $V_{CH} < V_{CSI} < V_{OI2}$ , the condition  $V_{DD} > V_{ODR}$

### 6. Charger Detection

Charger detection is this action: while connecting to a charger after entering into power-down mode, then if  $V_{CSI} < V_{CH}$ , M1 will be turned on when  $V_{DD} > V_{ODL}$ , and then the system will be back to normal condition as described in 1) of previous section.

### 7. Abnormal Charge Current Condition

The abnormal charge current condition is when a charger is connected to the battery system in normal condition, then if  $V_{DD} < V_{OCU}$  and  $V_{CSI} < V_{CH}$  occurs through a delay time than  $T_{OC}$  (delay time of overcharge detection), and in this condition M2 will be turned off to stop this charging status.

### 8. Over Current/Short Circuit Condition

The over current (or short circuit) condition is when the current is too large during discharging under normal condition as a result of the voltage detected by CSI is greater than  $V_{OI1}$  (or  $V_{OI2}$ ) through a delay time  $T_{OI1}$  ( $T_{OI2}$ ). In this over current (or short circuit) condition: M1 will be turned off and CSI will be pulled down to  $V_{SS}$  through an internal resistance.

### 9. Release of Over Current/Short Circuit Condition

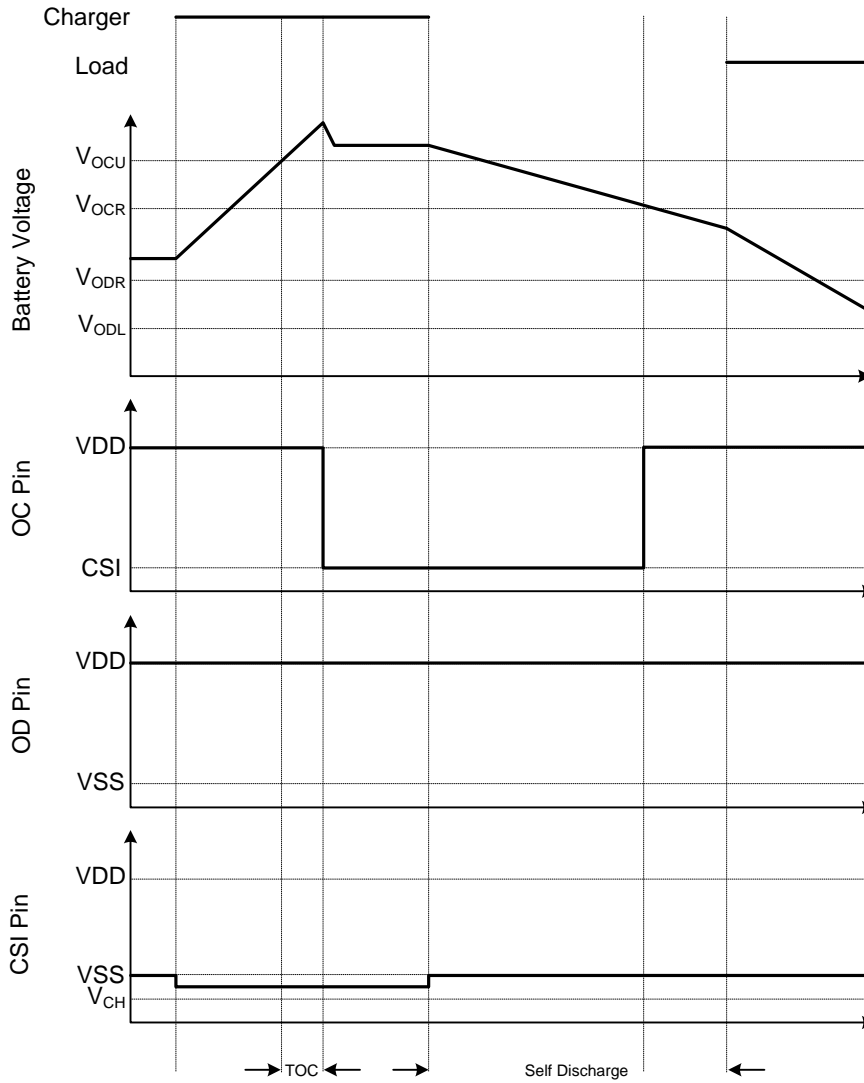
If the load is removed or the impedance between  $V_{BAT+}$  and  $V_{BAT-}$  is larger than  $500k\Omega$  as well as  $V_{CSI} < V_{OI1}$ , M1 will be turned on and the back to normal condition.

### 10. DS Pin

The delay time of the overcharge and overdischarge can be reduced to within 50ms by forcing DS to  $V_{DD}$ . A  $1.6M\Omega$  pull down resistor should be connected between DS pin and  $V_{SS}$  internally. In the actual application DS pin should be left open or connected to  $V_{SS}$ .

■ TIMING DIAGRAM

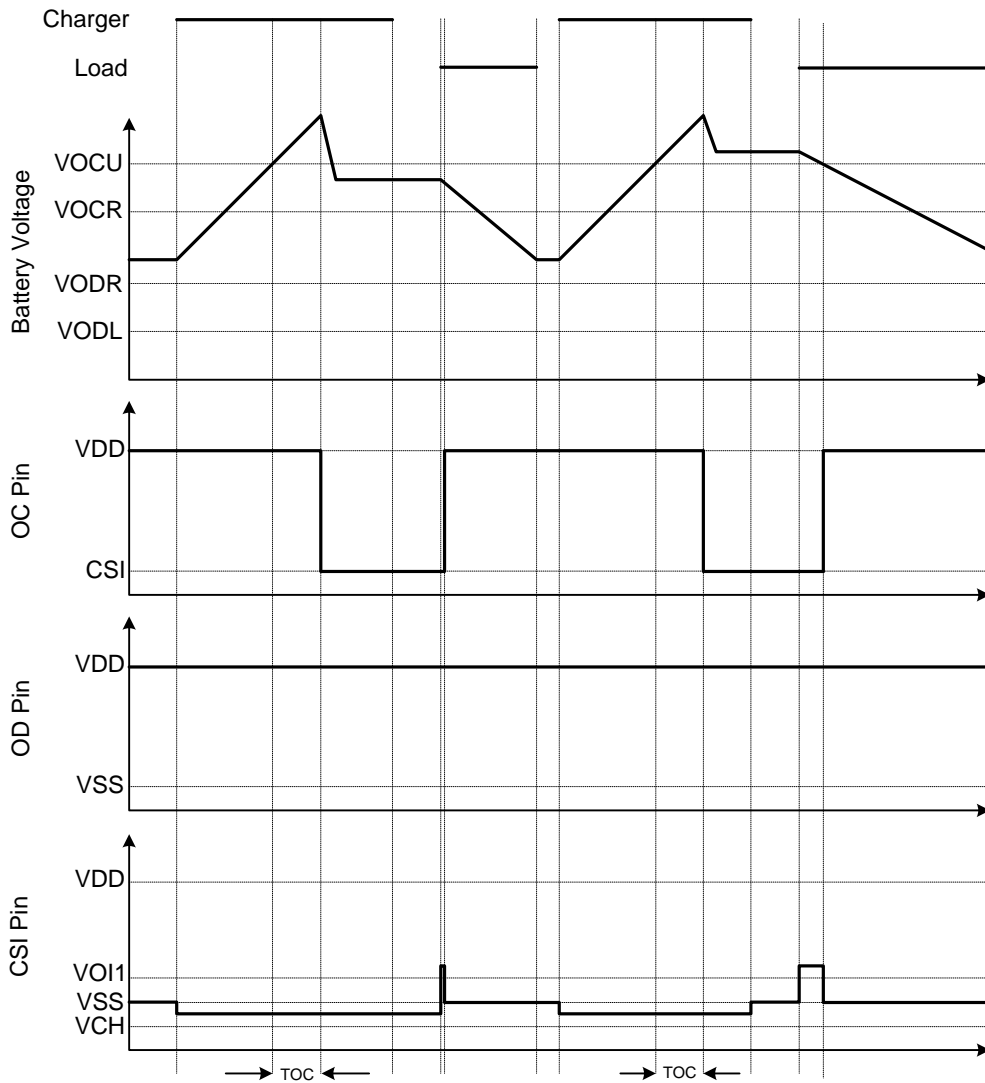
1. Overcharge Condition → Self Discharge → Normal Condition



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■ TIMING DIAGRAM(Cont.)

2. Overcharge Condition → Load Discharge → Normal Condition

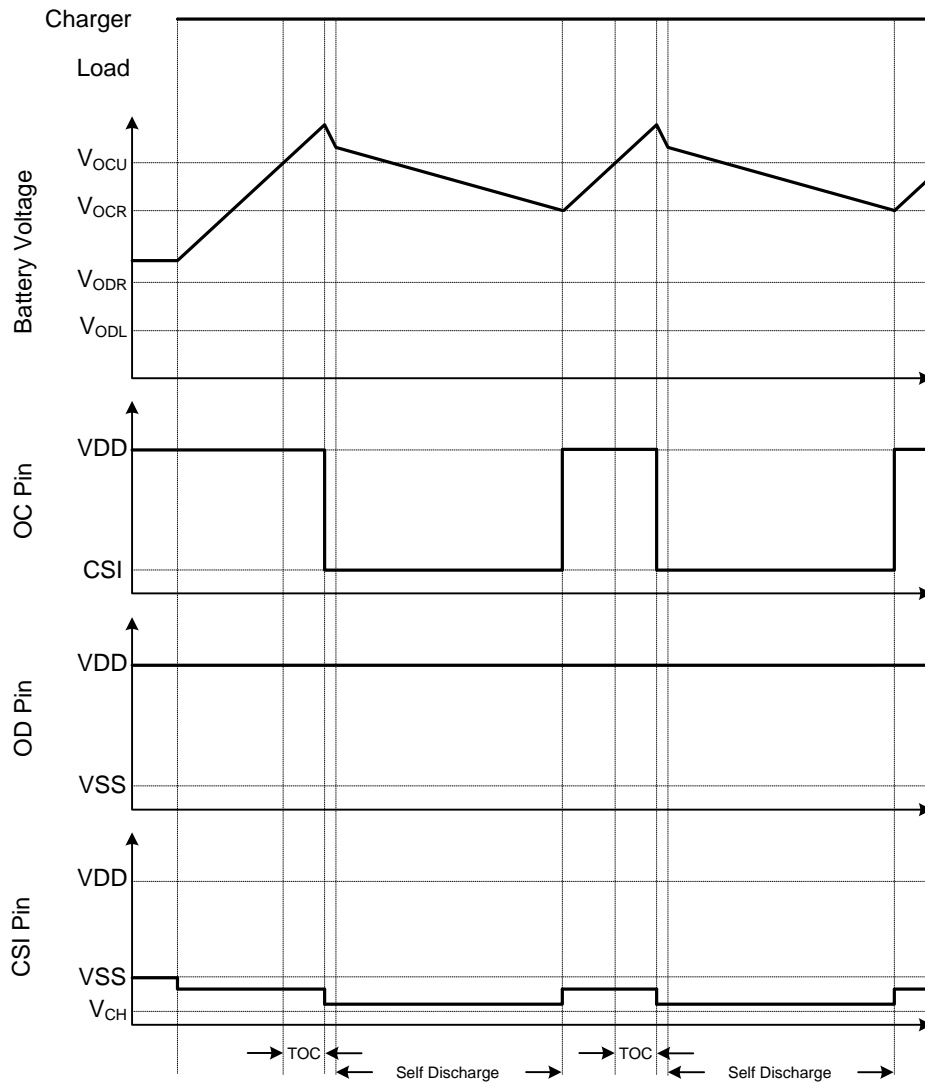


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■ TIMING DIAGRAM(Cont.)

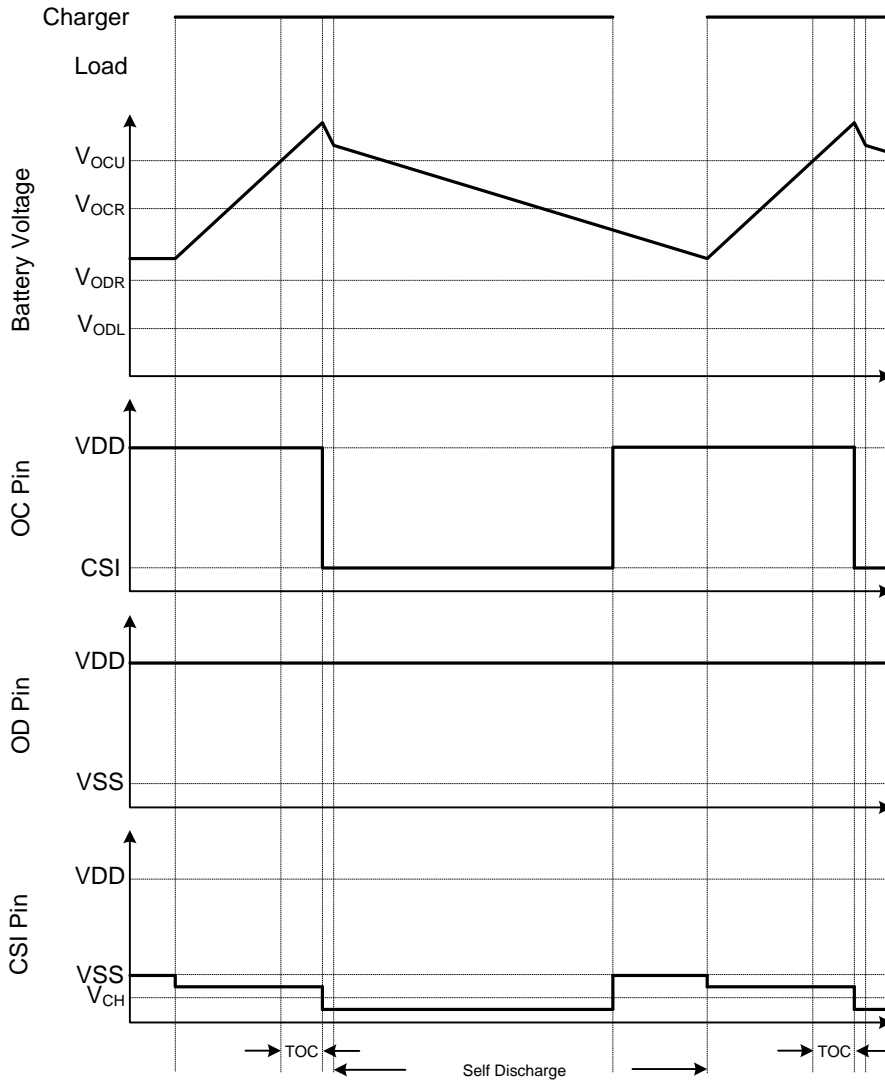
3. Overcharge Condition → Charger remains connected and  $V_{CSI} > V_{CH}$  → Self Discharge



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■ TIMING DIAGRAM(Cont.)

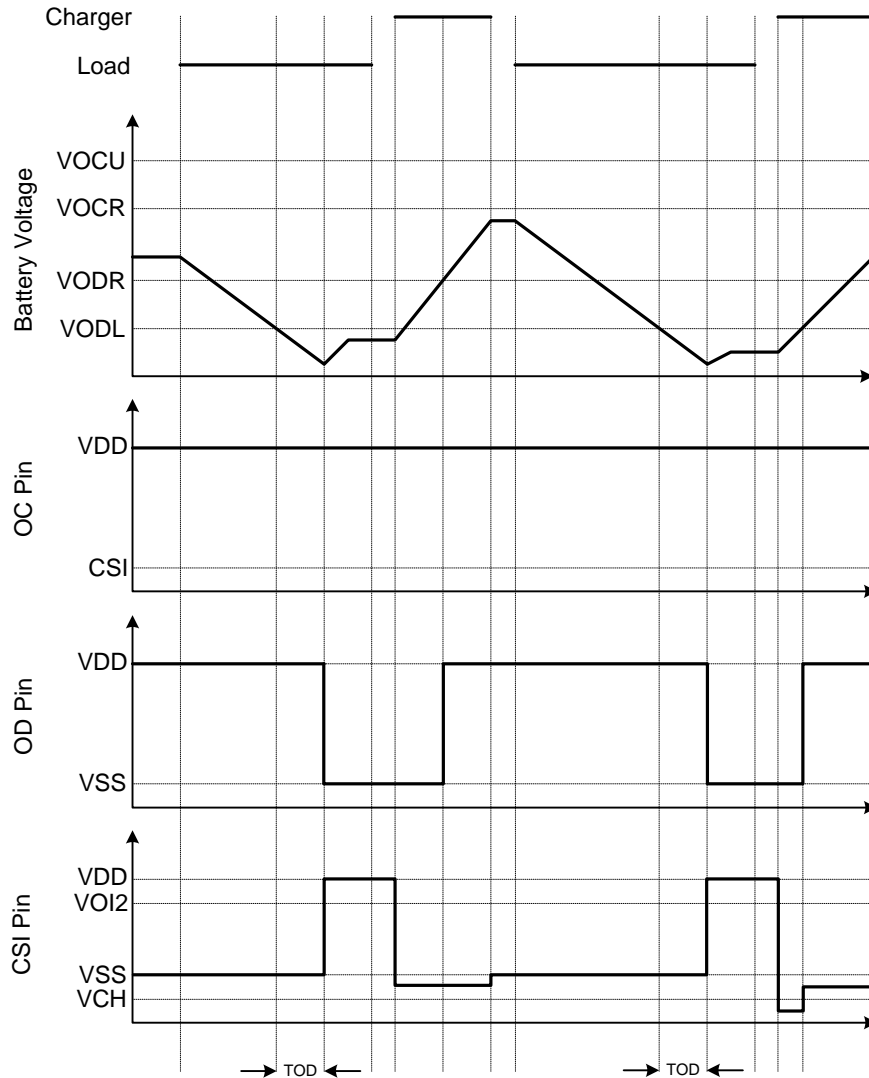
4. Overcharge Condition → Charger remains connected and  $V_{CSI} < V_{CH}$  → Self Discharge



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■ TIMING DIAGRAM(Cont.)

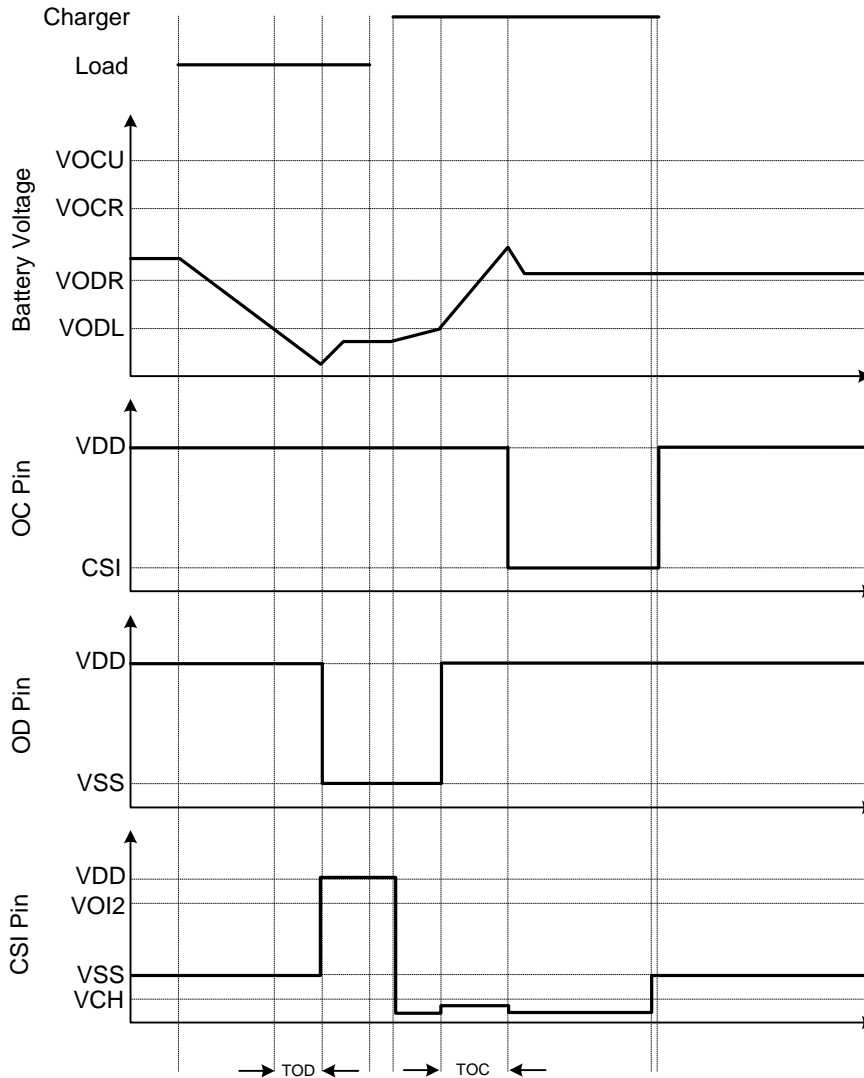
5. Overdischarge Condition → Charging By a Charger → Normal Condition



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■ TIMING DIAGRAM(Cont.)

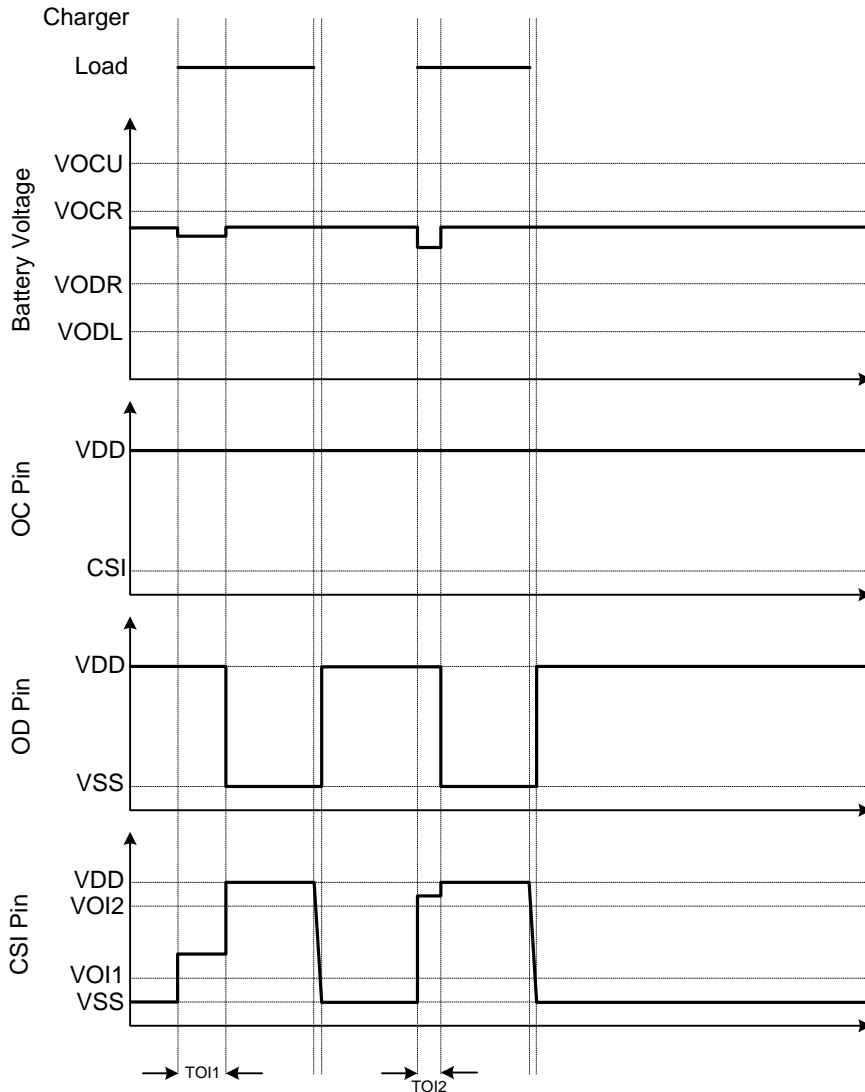
6. Overdischarge Condition → Abnormal Charger Current Condition → Normal Condition



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■ TIMING DIAGRAM(Cont.)

7. Over Current and Short Circuit Condition → Normal Condition



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