FS302 系列晶片說明書〔V1.3〕

鋰離子電池保護IC

1. Description

FS302電池保護晶片，是為了保護鋰離子電池避免因過度充電、過度放電或電流過大時，將電池破壞或縮短壽命而設計。它有高精準的電壓偵測與時間延遲電路，適用於保護單一鋰離子電池組。

2. 1-Cell Protection ICs

Model	Package	Overcharge detection voltage [VOCU] (V)	Overcharge release voltage [VOCR] (V)	Overdischarge detection voltage [VODL] (V)	Overdischarge release voltage [VODR] (V)	Overcurrent 1 detection voltage [VOI1] (mV)
	SOT-23-6					
FS302	AR	4.250±0.025	4.050±0.1	2.4±0.1	3.0±0.1	200±30
	BR	4.350±0.030	4.150±0.1	2.4±0.1	3.0±0.1	150±30
	CR	4.350±0.050	4.150±0.1	2.4±0.1	3.0±0.1	150±30
	DR	4.250±0.030	4.050±0.1	2.35±0.1	2.9±0.1	150±30

Overcharge and overdischarge voltages and overcurrent 1 detection voltage can be changed at the customer's request.

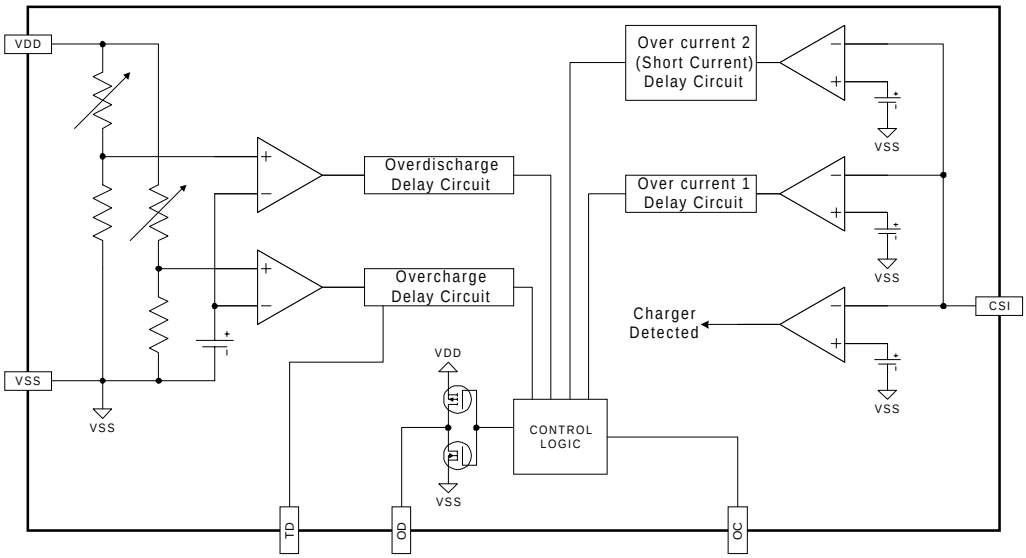
3. Features

1)	Low supply current	Operation: 3.0uA typ. @VDD=3.9V Power-down mode: 0.3uA typ. @VDD=2.0V
2)	Overcharge detection voltage〔VOCU〕	4.0V~4.4V, Accuracy of ±25/±30mV
3)	Overcharge release voltage〔VOCR〕	VOCR, Accuracy of ±100mV
4)	Overdischarge detection voltage〔VODL〕	2.3V~2.5V, Accuracy of ±100mV
5)	Overdischarge release voltage〔VODR〕	VODR, Accuracy of ±100mV
6)	Over current 1 detection voltage〔VOI1〕	VOI1
7)	Over current 2(Short Current) detection voltage〔VOI2〕	1.35V
8)	Overcharge detection delay time	C_{TD}=0.01uF,100ms
9)	Charger detection voltage	-0.6V
10)	Reset resistance for Over current protection	>500KΩ
11)	Wide supply voltage range	1.8 ~ 8.0V
12)	Small package	SOT-23-6

Applications

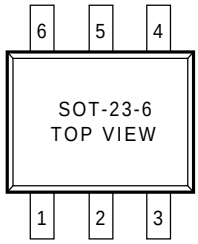
1) Protection IC for One-Cell Lithium-Ion Battery Pack

4. Block Diagram

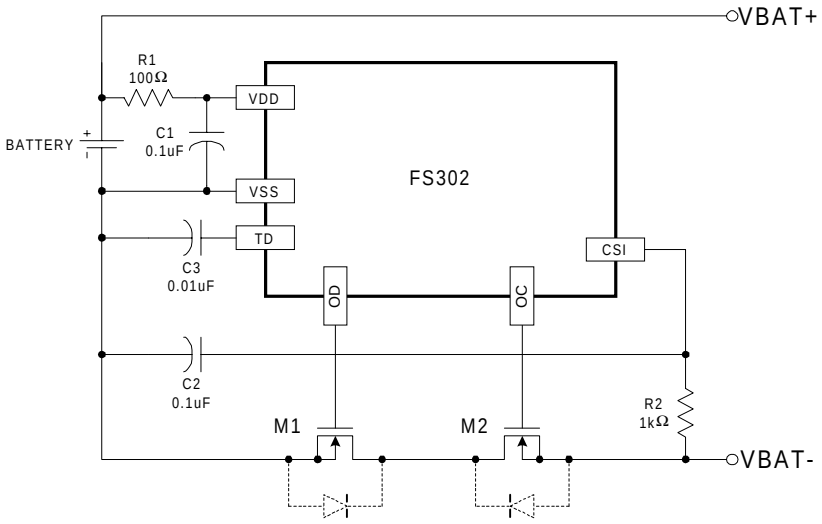


5. Pin Configuration

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 VOCU
5	VDD	Positive power input pin
6	VSS	Negative power input pin



6. Typical Application Circuit



7. Absolute Maximum Ratings

Item	Symbol	Rating	Unit
Supply voltage between VDD and VSS	VDD	VSS-0.3 to VSS+12	V
OC output pin voltage	VOC	VDD-15 to VDD+0.3	V
OD output pin voltage	VOD	VSS-0.3 to VDD+0.3	V
CSI input pin voltage	VCSI	VDD-15 to VDD+0.3	V
Operating Temperature Range	TOP	-10 to +70	℃
Storage Temperature Range	TST	-40 to +125	℃

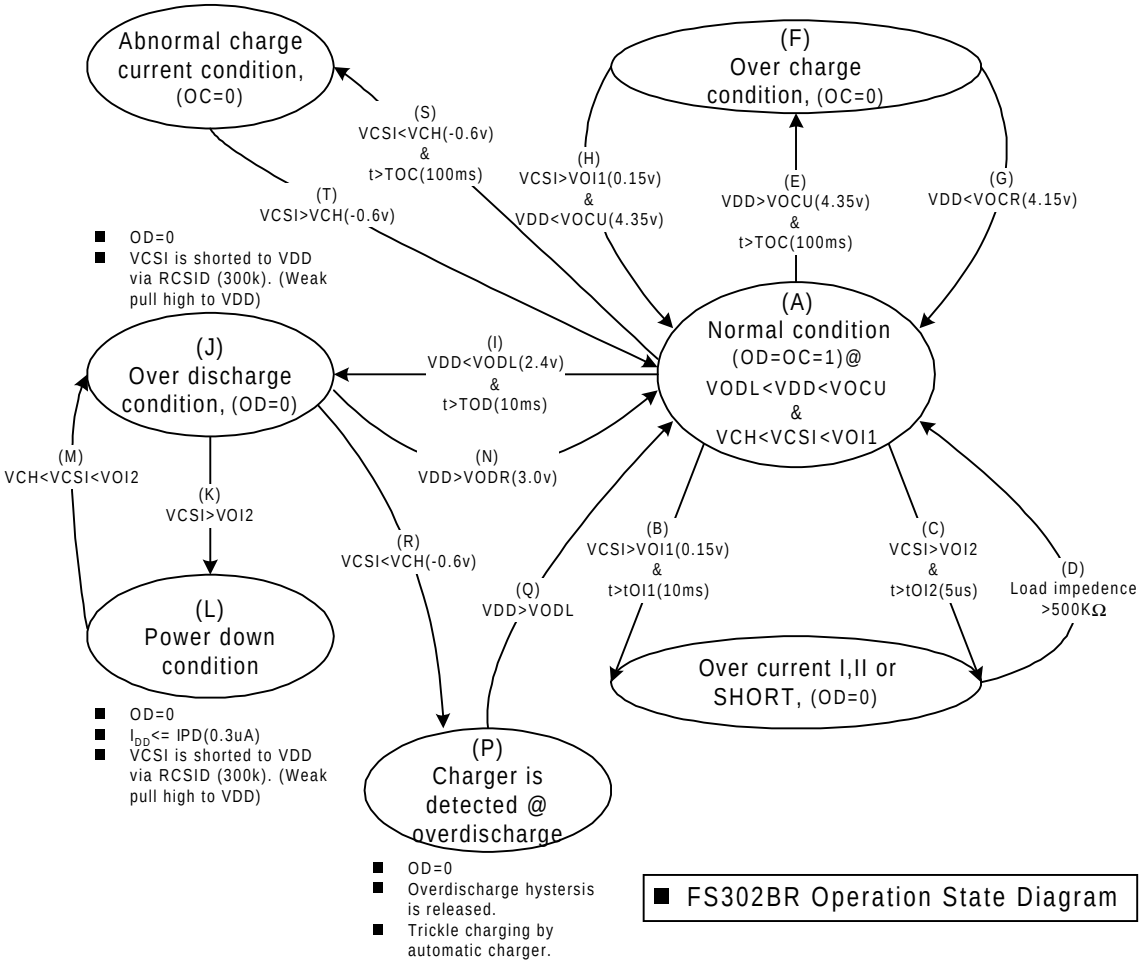
8. Electrical Characteristic

(Unless otherwise specified Ta=25℃, model name FS302BR)

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
CURRENT CONSUMPTION						
Supply Current	VDD=3.9V	IDD		3.0	6.0	uA

Power-Down Current	VDD=2.0V	IPD		0.3	0.6	uA
OPERATING VOLTAGE						
Operating voltage between VDD and VSS		VDD	1.8		8.0	V
DETECTION VOLTAGE						
Overcharge detection voltage		VOCU	4.32	4.35	4.38	V
Overcharge release voltage		VOCR	4.05	4.15	4.25	V
Overdischarge detection voltage		VODL	2.30	2.40	2.50	V
Overdischarge release voltage		VODR	2.90	3.00	3.10	V
Over current 1 detection voltage		VOI1	0.12	0.15	0.18	V
Over current 2 (Short Current) detection voltage	VDD=3.6V	VOI2	1.25	1.35	1.45	V
Reset resistance for Over current protection	VDD=3.6V	Rshort	400	500	600	KΩ
Charger detection voltage		VCH	-0.8	-0.6	-0.4	V
DELAY TIME						
Overcharge detection delay time	C_{TD}=0.01uF	TOC	50	100	150	ms
Overdischarge detection delay time	VDD=3.6V to 2.0V	TOD	5	10	15	ms
Over current 1 detection delay time	VDD=3.6V	TOI1	5	10	15	ms
Over current 2 (Short Current) detection delay time	VDD=3.6V	TOI2		5	50	us
OTHER						
OC pin output “H” voltage		Voh1	VDD-0.1	VDD-0.02		V
OC pin output “L” voltage		Vol1		0.01	0.1	V
OD pin output “H” voltage		Voh2	VDD-0.1	VDD-0.02		V
OD pin output “L” voltage		Vol2		0.01	0.1	V

9. State Diagram of Operation



10. Description of Operation

10.1 正常情況

若VODL<VDD<VOCU且VCH<VCSI<VOI1，則M1與M2均Turn ON，此時充電與放電均可正常進行。

10.2 過度充電情況

當由正常情況進入充電情況時，可由VDD偵測到電池電壓。當電池電壓進入過度充電情況時，VDD電壓會大於VOCU，且若時間大於TOC，則會將M2 Turn OFF。

10.3 解除過度充電情況

進入過度充電情況後，要解除過度充電情況，進入正常情況，有兩種機制。

1) 透過自我放電，若VDD<VOCR，則M2 Turn ON，進入正常情況。
2) 移去充電器，接上負載後，此時若VOCR<VDD<VOCU而且VCSI>VOI1，則M2 Turn ON，進入正常情況。

10.4 過度放電情況

當由正常情況進入放電情況時，可由VDD偵測到電池電壓。當電池電壓進入過度放電情況時，VDD電壓會小於VODL，且若時間大於TOD，則會將M1 Turn OFF，此時CSI接腳會透過晶片一個內部電阻RCSID，拉到VDD電壓。此時，若VCSI>VOI2，則晶片將進入Power-down mode (耗電流小於0.3uA)。

10.5 解除Power-down mode

進入Power-down mode後，若接上充電器，此時若VCH<VCSI<VOI2，且VDD<VODR，則會解除Power-down mode〔但M1仍然OFF〕。此時若VDD>VODR，則M1 Turn ON，進入正常情況。

10.6 偵測充電器情況

進入Power-down mode後，若接上充電器後，若VCSI<VCH，且VDD>VODL，則將M1 Turn ON，進入正常情況。

10.7 不正常充電情況

進入正常情況後，當接上充電器充電時，若VCSI<VCH且時間大於TOC，則會將M2 Turn OFF。

10.8 過電流(短路)情況

進入放電情況時，若放電電流過大，由CSI接腳偵測到電壓大於VOIX (VIO1 or VIO2)，且時間大於TOIX (TIO1 or TIO2)時，則代表過電流(短路)情況，此時會將M1 Turn OFF，且CSI接腳會透過晶片內部一個電阻RCSIS，拉到VSS電壓。

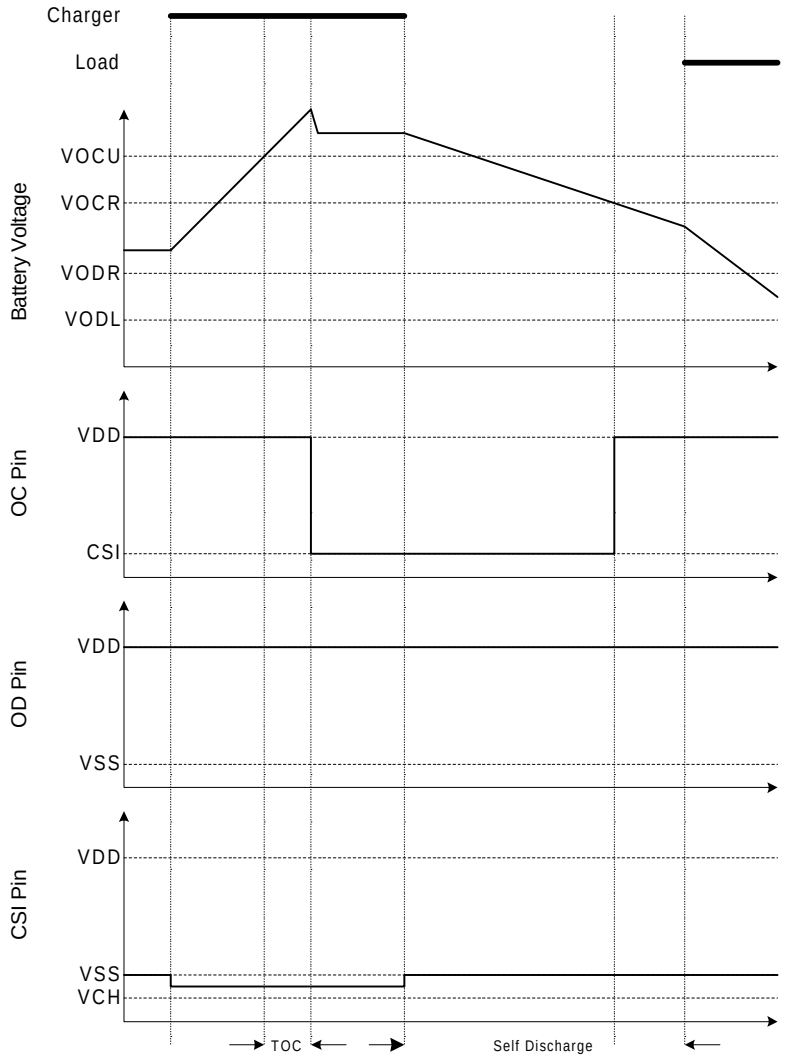
10.9 解除過電流(短路)情況

當進入過電流(短路)情況後，若移去負載或介於VBAT+與VBAT-間之阻抗大於500KΩ，且VCSI<VOI1，則會將M1 Turn ON，進入正常情況。

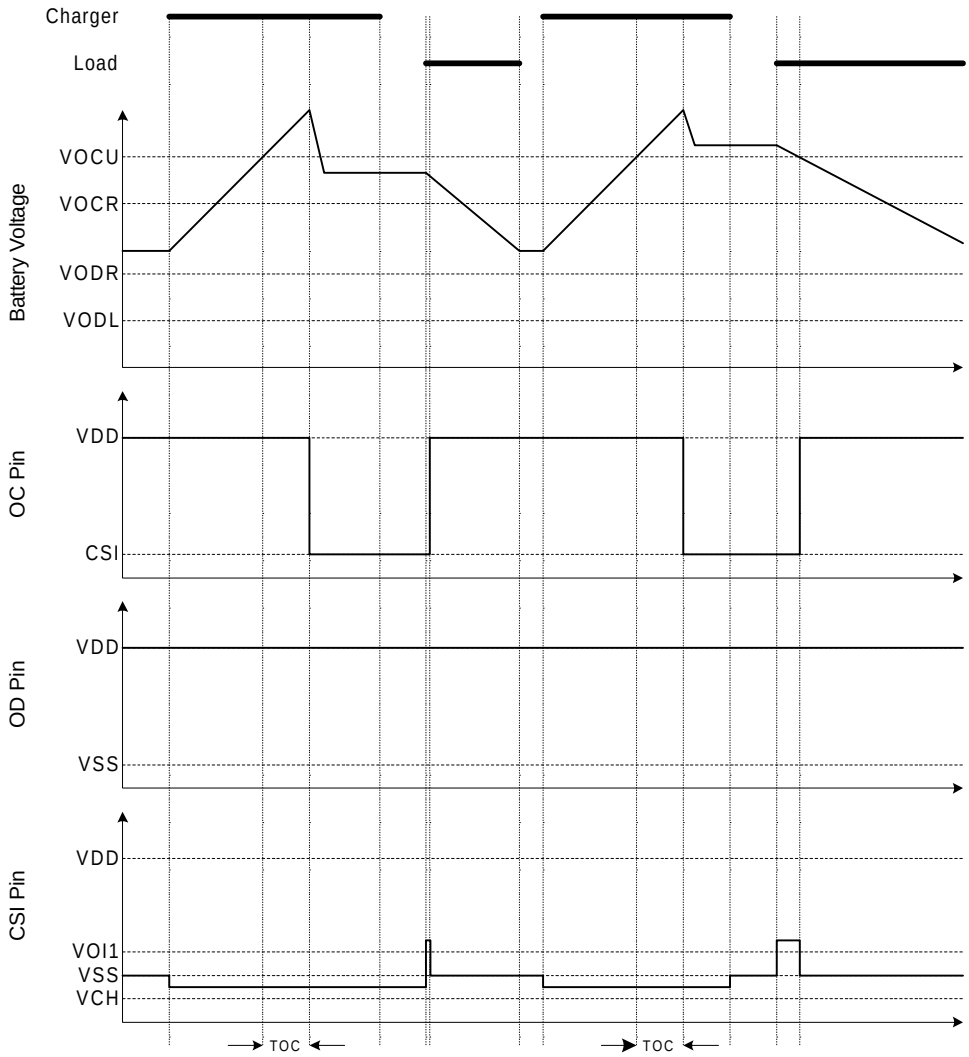
註：當電池第一次接上保護板時，保護IC可能不會進入正常情況(Normal condition)，此時無法放電。若此現象發生，令CSI電壓等於VSS電壓(將CSI與VSS短路或連接充電器)即可解開此現象，使保護IC進入正常情況。

11. Timing Diagram

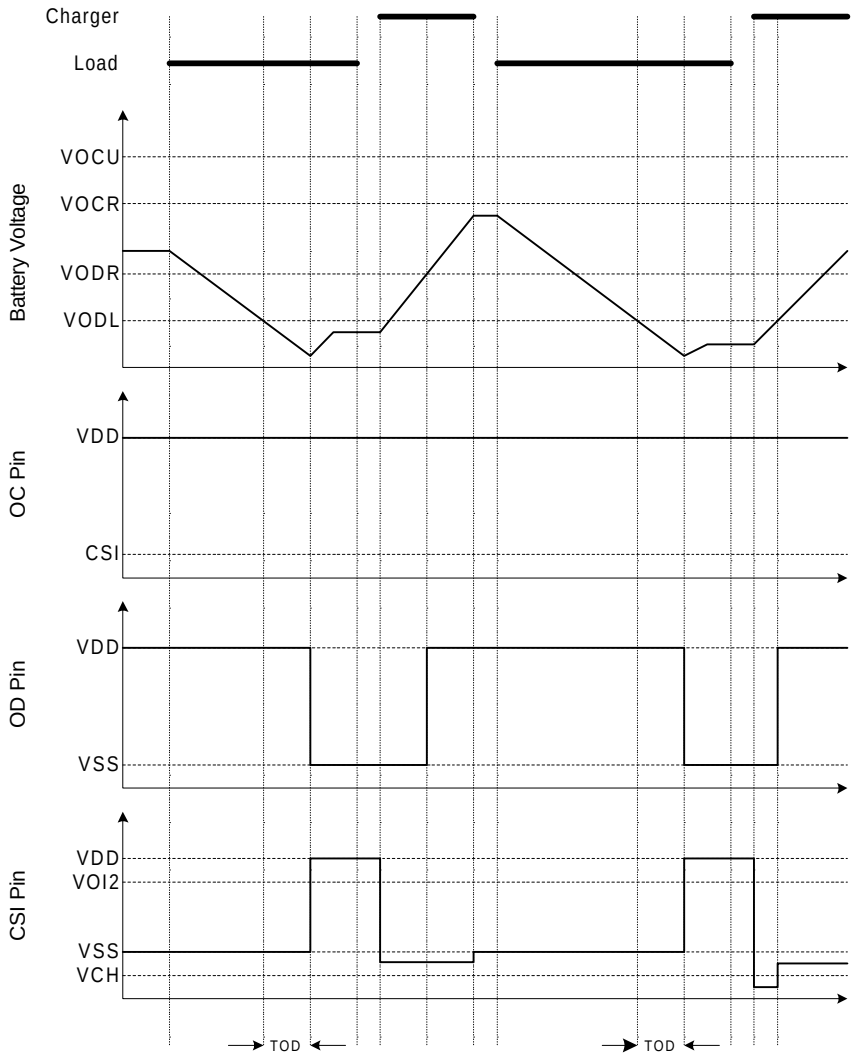
11.1 過度充電情況→自我放電→正常情況



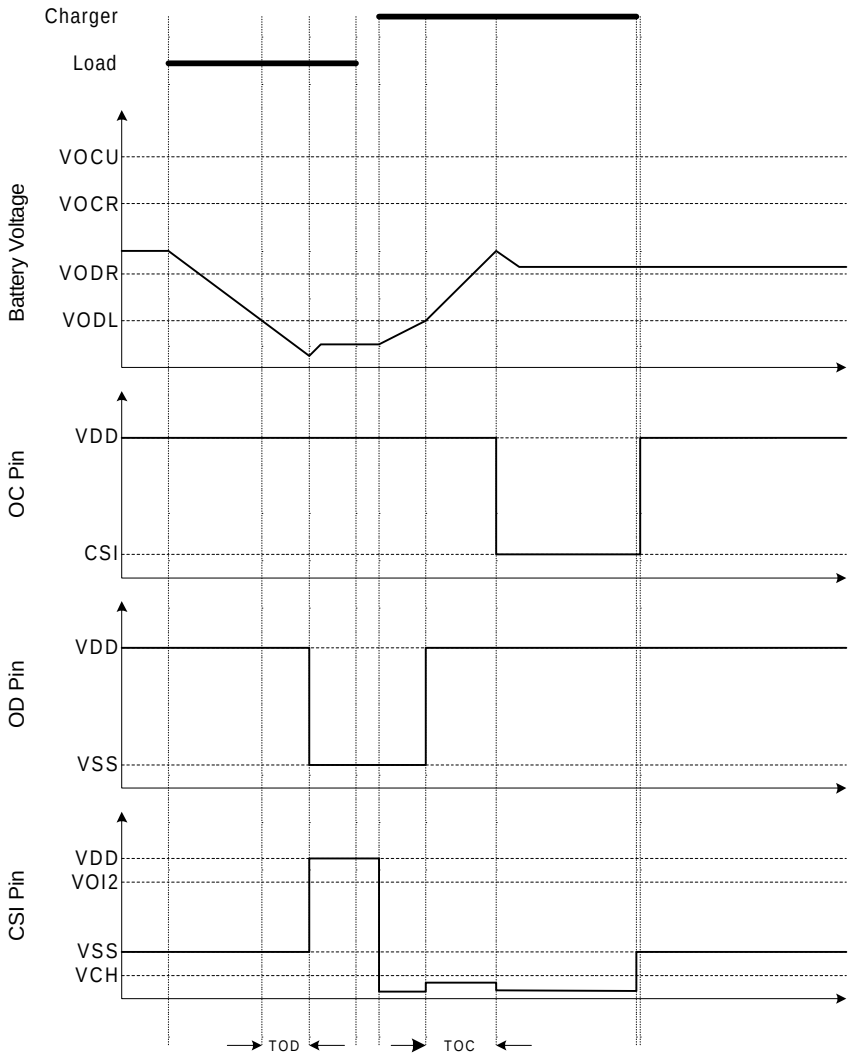
11.2 過度充電情況→負載放電→正常情況



11.3 過度放電情況→充電器充電→正常情況



11.4 過度放電情況→不正常充電→正常情況



11.5 過電流(短路)情況→正常情況