SIT2122
Data Sheet

2-Cell LiFePO4 Battery Packs Protection ICs

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1. General Description

SIT2122 IC is best created for 2-cell LiFePO4 battery protection and it also comprises high-accuracy voltage detectors and delay circuits.

It is suitable for protecting 2-cell LiFePO4 battery packs against the problems of overcharge, overdischarge and overcurrent.

2. Features

(1) High-accuracy voltage detection circuit

- Overcharge detection voltage V_{CUn} (n＝1,2) 3.65 Accuracy ±25mV
- Overcharge release voltage V_{CRn} (n＝1,2) 3.40 Accuracy ±50mV
- Overdischarge detection voltage V_{DLn} (n＝1,2) 2.0 Accuracy ±80mV
- Overdischarge release voltage V_{DRn} (n＝1,2) 2.50V Accuracy ±100mV
- Discharge overcurrent detection voltage 200mV
- Charge overcurrent detection voltage 200mV Accuracy ±20mV
- Short-circuiting detection voltage 1.0V(fixed) Accuracy ±0.4V

(2) 3-level discharge overcurrent detection (discharge overcurrent 1, discharge overcurrent 2, short circuit detection)

(3) Delay times are generated by an internal circuit (external capacitors are unnecessary).

- Overcharge delay time 1300ms typ.
- Over discharge delay time 160ms typ.
- Discharge overcurrent delay time 10ms typ.
- Charge overcurrent detection voltage 7ms typ.
- Short circuit delay time 200μs typ.

(4) Low current consumption (Products with Power-down Function)

- Operation mode 7μA typ., 9.0μAmax. (VCC=6.4V)
- Ultra low power-down current at 0.1μA max.

(5) High-withstanding-voltage device is used for charger connection pins (CS pin and OC pin : Absolute maximum rating = 32 V)

(6) 0 V battery charge function “available” / “unavailable” are selectable

(7) Wide operating temperature range −40°C to +85 °C

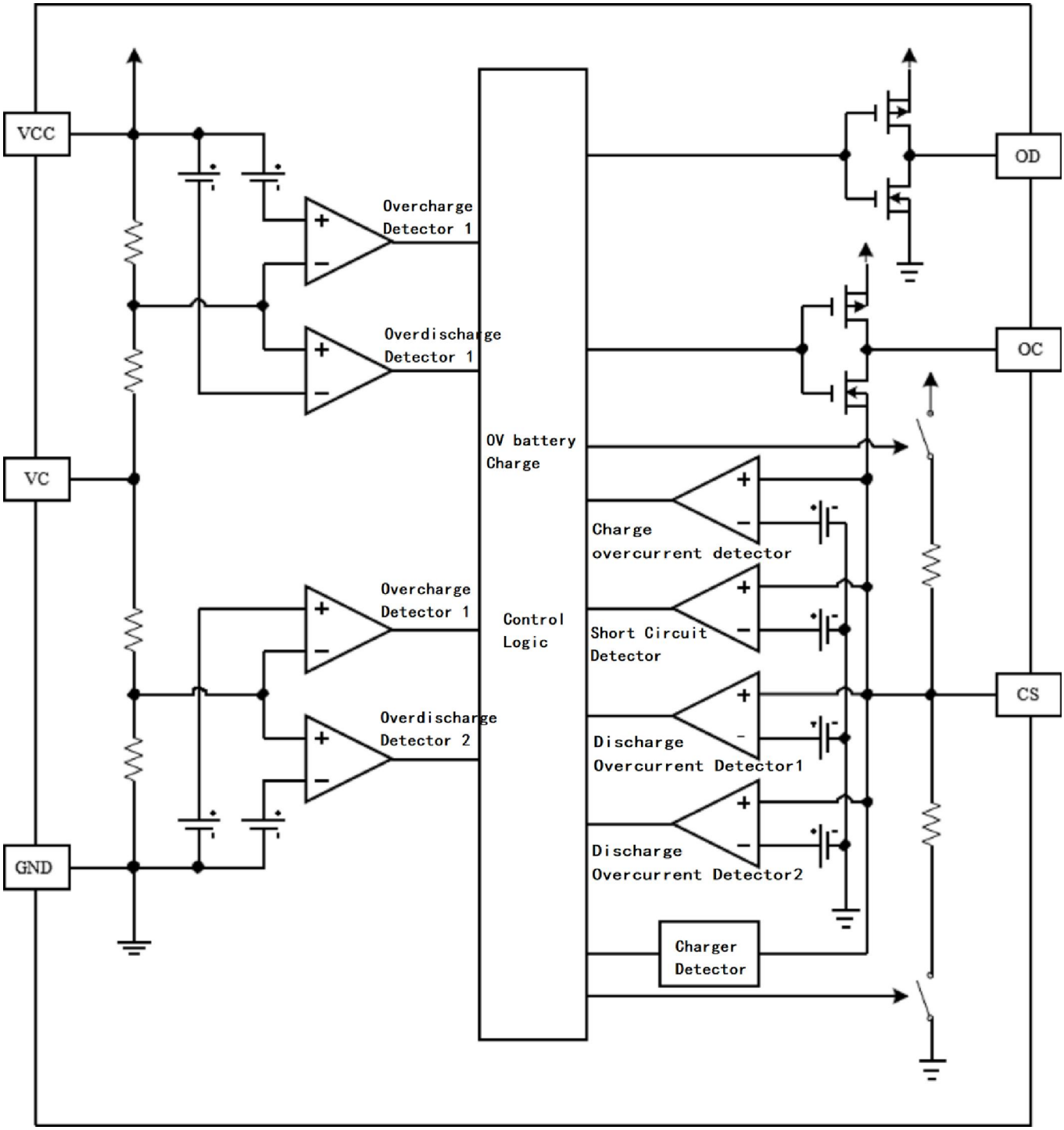
(8) Small package SOT-23-6

(9) SIT2122 is Halogen-free, green package

3. Applications

2-cell LiFePO4 rechargeable battery packs

4. Block Diagram



5. Absolute Maximum Ratings

Absolute Maximum Ratings (GND=0V, Ta=25°C unless otherwise specified)

Item	Symbol	Rating	Unit
Input voltage between VCC and GND pin	V_{CC}	GND-0.3 to GND+13	V
OC output pin voltage	V_{OC}	V_{CS}-0.3 to V_{CC}+0.3	V
OD output pin voltage	V_{OD}	GND-0.3 to V_{CC}+0.3	V
CS input pin voltage	V_{CS}	V_{CC}-30 to V_{CC}+0.3	V
Operating Temperature Range	T_{OP}	-40 to +85	°C
Storage Temperature Range	T_{ST}	-40 to +125	°C
Power dissipation	P_D	245	mW

6. Electrical Characteristics

6.1 Electrical Characteristics (Except Delay Time Parameter)

Electrical Characteristics (GND=0V, Ta=25°C unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
SUPPLY POWER RANGE						
Operating voltage between VCC pin and GND pin	V_{DSOP1}	-	1.5	-	10	V
Operating voltage between VCC pin and CS pin	V_{DSOP2}	-	1.5	-	30	V
INPUT CURRENT(with Power-down Function)						
Supply Current	I_{OPE}	VCC=6.4V	-	7.0	10.5	μA
Power-Down Current	I_{PD}		-	-	0.1	μA
INPUT CURRENT(with Auto Overdischarge Recovery Function)						
Supply Current	I_{OPE}	VCC=6.4V	-	7.0	10.5	μA
Power-Down Current	I_{OPE}		-	7.0	10.5	μA
DETECTION VOLTAGE						
Overcharge Detection Voltage cell n (*1)	V_{CUn}	3.6V to 4.0V adjustable	V_{CUn}-0.025	V_{CUn}	V_{CUn}+0.025	V
Overcharge Release Voltage cell n (*1)	V_{CLn}	3.4V to 4.0V adjustable	V_{CLn} -0.05	V_{CLn}	V_{CLn} +0.05	V
Overdischarge Detection Voltage cell n (*1)	V_{DLn}	1.8V to 2.2V adjustable	V_{DLn} -0.1	V_{DLn}	V_{DLn} +0.10	V
Overdischarge Release Voltage cell n (*1)	V_{DUn}	1.8V to 2.5V adjustable	V_{DUn} -0.10	V_{DUn}	V_{DUn} +0.10	V
Discharge Overcurrent Detection Voltage 1	V_{OC1}		0.18	0.20	0.23	V
Discharge Overcurrent Detection Voltage 2	V_{OC2}		0.30	0.38	0.46	V
Short Circuit Detection Voltage	V_{SIP}	VCC-GND=6.0V	0.8	1.0	1.2	V
Charge Overcurrent Detection Voltage	V_{COC}		-0.28	-0.20	-0.15	V
Charger Detection Voltage	V_{CHG}		-0.28	-0.20	-0.15	V
CONTROL OUTPUT VOLTAGE(OD&OC)						
OD Pin Output “H” Voltage	V_{DH}		VCC-0.1	VCC-0.02		V
OD Pin Output “L” Voltage	V_{DL}			0.2	0.5	V
OC Pin Output “H” Voltage	V_{CH}		VCC-0.1	VCC-0.02		V
OC Pin Output “L” Voltage	V_{CL}			0.2	0.5	V
0V BATTERY CHARGE FUNCTION						
Charger start voltage(available 0V battery charge function)	V_{0CH}	Available 0V battery charge function	1.2	-	-	V

INTERNAL RESISTANCE						
Resistance in CS-VCC	R_{CSC}	V1=V2=1.5V, VCS=0V	100	300	900	KΩ
Resistance in CS-GND	R_{CSD}	V1=V2=3.2V, VCS=1.0V	5	10	20	KΩ
OUTPUT RESISTANCE						
OC "H" Resistance	ROC(H)	VOC=VCC-0.5V	2	5	10	KΩ
OC "L" Resistance	ROC(L)	VOC=VCS+0.5V	2	4.5	8	MΩ
OD "H" Resistance	ROD(H)	VOD=VCC-0.5V	2	5	10	KΩ
OD "L" Resistance	ROD(L)	VOD=GND+0.5V	2	5	10	KΩ

NOTE:

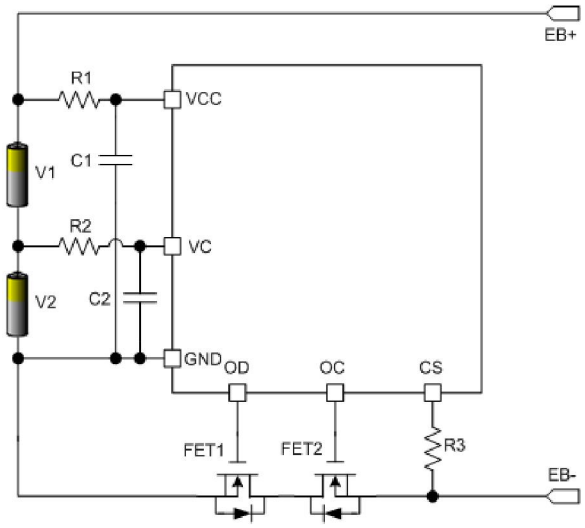
*1. n=1,2

6.2 Delay Time Combination

Delay Time Parameter Combination of Delay Time Code: 1

Item	Symbol		Min.	Typ.	Max.	Unit
Overcharge Delay Time	t_{CU}	V1=3.2V V2=3.2V →3.8V	0.9	1.3	1.7	s
Overdischarge Delay Time	t_{DL}	V1=3.2V V2=3.2V →1.8V	120	160	200	ms
Charge Overcurrent Delay Time	t_{COC}	V_{CS}=0V→-0.25V	6	10	14	ms
Discharge Overcurrent Delay Time 1	t_{OC1}	V_{CS}=0V →0.25V	6	10	14	ms
Discharge Overcurrent Delay Time 2	t_{OC2}	V_{CS}=0V →0.7V	2	5	8	ms
Short Circuit Delay Time	t_{SIP}	V_{CS}=0V →1.5V	100	200	400	μs

7. Battery Protection IC Connection Example



Symbol	Device Name	Purpose	Min.	Typ.	Max.	Remark
R1	Resistor	limit current, stabilize VCC and strengthen ESD protection	300Ω	**470Ω**	1KΩ	*1
R2	Resistor	limit current, stabilize VC and strengthen ESD protection	300Ω	**470Ω**	1KΩ	*1
R3	Resistor	limit current	300Ω	**2kΩ**	4kΩ	*2
C1	Capacitor	Filter, stabilize VCC	0.022μF	**0.1μF**	1.0μF	*3
C2	Capacitor	Filter, stabilize VCC	0.022μF	**0.1μF**	1.0μF	*3
M1	N-MOSFET	Discharge control	-	-	-	*4
M2	N-MOSFET	Charge control	-	-	-	*5

*1. If R1 or R2 connects with an over-spec resistor, battery accuracy may be influenced due to R1 or R2 voltage drop that caused by current consumption. When a charger is connected in reversed, the current flows from the charger to the IC. At this time, if R1 or R2 is too high, the voltage between VCC pin and GND pin may exceed the absolute maximum rating.

*2. If R3 connects with an over-spec resistor, the charging current may not be cut off when a high-voltage charger is connected. Please select as large a resistor as possible to control current when a charger is connected in reversed.

*3. C1 & C2 can stabilize the supply voltage of VCC, the value of C1 & C2 should be equal to or more than 0.01μF.

*4. If a MOSFET with a threshold voltage that is the same or more than overdischarge detection voltage is applied, discharging may be stopped before overdischarge is detected.

*5. If the withstanding voltage between the gate and source is lower than the charger voltage, the FET may be destroyed.

Caution：

1. The above constants may be changed without notice, please download the most up-to-date datasheet on our website: www.hlec.com.cn
2. It is advised to perform thorough evaluation and test if peripheral devices need to be amended.

8. Description of Operation

8.1. Normal Status

This IC monitors the voltage of the battery connected between the VCC pin and GND pin and the voltage difference between the CS pin and GND pin to control charging and discharging.

When the cell1 and cell2 voltage is in the range from overdischarge detection voltage (V_{DLn}) to overcharge detection voltage (V_{CUn}), and the CS pin voltage is in the range from the charge overcurrent detection voltage (V_{CIP}) to discharge overcurrent detection voltage (V_{DIP}), the IC turns both the charging and discharging control MOSFET on. This condition is called the normal status. Under this condition, charging and discharging can both be carried out freely.

Notice: Discharging may not be enacted when the battery is first time connected. To regain normal status, CS and GND PIN must be shorted or the charger must be connected.

8.2. Overcharge Status

The normal state of the battery voltage between VCC pin and VC pin (the voltage of Cell 1) and the voltage between VC pin and GND pin (the voltage of Cell2), if either voltage becomes equal or more than the overcharge detector voltage (V_{CUn}), and continued exceed overcharge delay time (T_{OC}) an external charge control Nch MOSFET turns off with OC pin being at "L" level.

To reset the overcharge and make the OC pin level to "H" again after detecting overcharge, in such conditions that a time when the both Cell1 and Cell2 are down to a level lower than overcharge voltage, by connecting a kind of load to VCC after disconnecting a charger from the battery pack. Then, the output voltage of OC pin becomes "H", and it makes an external Nch MOSFET turn on, and charge cycle is available. In other words, once overcharge is detected, even if the supply voltage becomes low enough, if a charger is continuously connected to the battery pack, recharge is not possible.

Further, either or both voltage of Cell1 and Cell2 is higher than the overcharge detector threshold, if a charger is removed and some load is connected, OC outputs “L”, however, load current can flow through the parasitic diode of the external charge control Nch MOSFET. After that, when the VCC pin voltage becomes lower than the overcharge detector threshold, OC becomes “H”.

Internal fixed output delay times for overcharge detection. If either or both of the voltage of Cell1 or Cell2 keeps its level more than the overcharge detector threshold, and output delay time passes, overcharge voltage is detected. Even when the voltage of Cell1 or Cell2 level becomes equal or higher level than overcharge detection voltage (V_{CUn}) if these voltages would be back to a level

lower than the overcharge detector threshold within a time period of the output delay time, the overcharge is not detected.

8.3. Overdischarge Status

Batteries under normal operation mode, voltage of cell 1 that connected to VCC and VC pin or voltage of cell 2 that connected to VC and GND pin drops lower than overdischarge detection voltage (V_{DLn}) and the mode continues longer than overdischarge detection delay time (T_{OD}) during discharging, SIT2122 series will turn the OD pin output voltage from high level to low level and turn the discharging control MOSFET off (OD pin) so as to stop discharging. This condition is called the “Overdischarge Status”.

8.3.1 Products with Power-down Function

When MOSFET is off, CS pin voltage is pulled up by IC internal resistor to VCC, reducing IC power consumption value to that of in the sleep mode (<0.1uA). This condition is called the “Sleep Mode”. The overdischarge status will be leased by two following cases. OD pin output voltage turns from low level to high level, conducting discharge control MOSFET.

(1) If CS pin voltage lowers than charge overcurrent detection voltage (V_{CIP}) when charger is connected, voltage of cell 1 and cell 2 goes higher than overdischarge detection voltage（V_{DLn}）, the overdischarge status is released and back to normal operation mode.

(2) If CS pin voltage is higher than charge overcurrent detection voltage (V_{CIP}) when charger is connected, voltage of cell 1 and cell 2 goes higher than overdischarge release voltage (V_{DRn}), the overdischarge status is released and back to normal operation mode.

8.3.2 Products with Auto Overdischarge Recovery Function

The overdischarge status will be released by three cases:

(3) When CS pin voltage is equal to or lower than the charge overcurrent detection voltage (V_{CIP}) by charging and the VCC pin voltage is higher than the overdischarge detection voltage (V_{DL}).

(4) When CS pin voltage is equal to or higher than the charge overcurrent detection voltage (V_{CIP}) by charging and the VCC pin voltage is higher than the overdischarge release voltage (V_{DR}).

(5) Without connecting a charger, if the VCC pin voltage is higher than overdischarge release voltage (V_{DR}), the overdischarge status will be released, namely Auto Overdischarge Recovery Function.

Notice：

① When voltage of cell 1 and cell 2 lowers than overdischarge detection voltage (V_{DLn}) and stayed within overdischarge detection delay time (T_{OD}), the voltage of cell 1 and cell 2 increases higher than overdischarge detection voltage (V_{DLn}), it will not enter into overdischarge protection mode.

② The output type of OD pin is having "H" level of VCC and "L" level of GND.

8.4. Discharge Overcurrent Status (Discharge Overcurrent & Short Circuit)

The IC continuously monitor discharge current by examining CS pin voltage when batteries under normal operation. Once the voltage of CS pin exceeds that of discharge overcurrent detection

voltage (V_{DIP}) and this status lasts longer than discharge overcurrent delay time (T_{DIP}), and voltage output of OD pin changes from high potential to low potential, the MOSFET (OD pin) is disabled and discharge stopped. This status is called “Discharge Over-current Status”.

When CS pin voltage excels short circuit detection voltage (V_{SIP}) and this status lasts longer than short circuit delay tome (T_{SIP}), voltage output of OD pin changes from high potential to low potential. At this time, the MOSFET (OD pin) is disabled and discharge stopped. This status is called “Short Circuit Status”.

Discharge over-current status and short current status is released while the connected impedance between PB+ and PB- is larger than 450kΩ (typ.).

Additionally, when charger is connected, even the impedance between PB+ and PB- lowers than 450kΩ (typ.) and CS pin voltage lowers than discharge overcurrent detection voltage (VDIP), the discharge over-current status or short circuit status will still be released and back to normal operation mode.

8.5. Charge Overcurrent Status

When CS pin voltage lowers than charge overcurrent detection voltage (V_{CIP}) and this status lasts longer than charge overcurrent delay time (T_{CIP}) during charge process of batteries under normal operation, OC pin voltage output will change from high potential to low potential. At this time, MOSFET (OC pin) is disabled and charge stopped. This status is called “Charge Overcurrent Status”.

If CS pin voltage increases higher than charge overcurrent detection voltage (V_{CIP}) by disconnecting charger after enter charge overcurrent status, the charge overcurrent status will be released and restore to normal operation mode.

8.6. 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 (V_{0CH}) or a higher voltage is applied between the battery+ (PB+) and battery- (PB-) pins by connecting a charger, the charging control MOSFET gate is fixed to the VCC 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 detection voltage (V_{DL}), the SIT2122 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 (V_{DL}).

8.7. 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 (V_{0IN}) 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 (V_{0IN}) or higher, charging can be implemented.

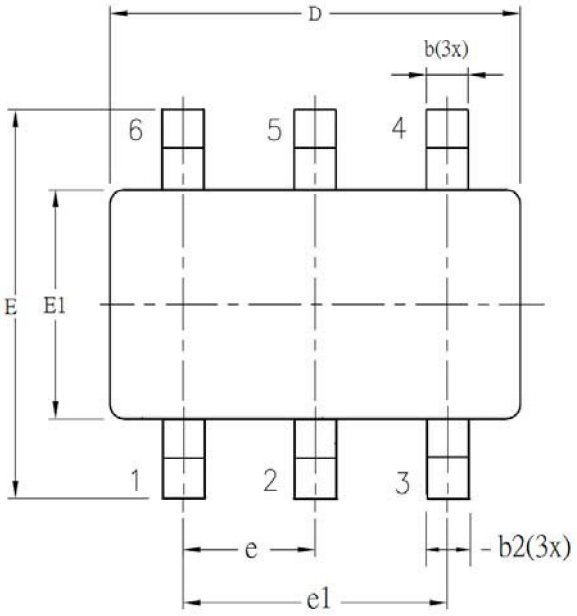
Caution

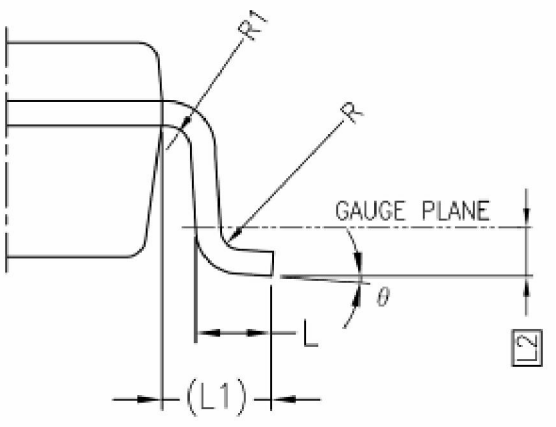
(1) Some battery providers do not recommend charging for a completely self-discharged battery. Please ask the battery provider to determine whether to enable or prohibit the 0V battery charging function.

9. Package information

SOT-23-6

NOTE: All dimensions are in millimeters.

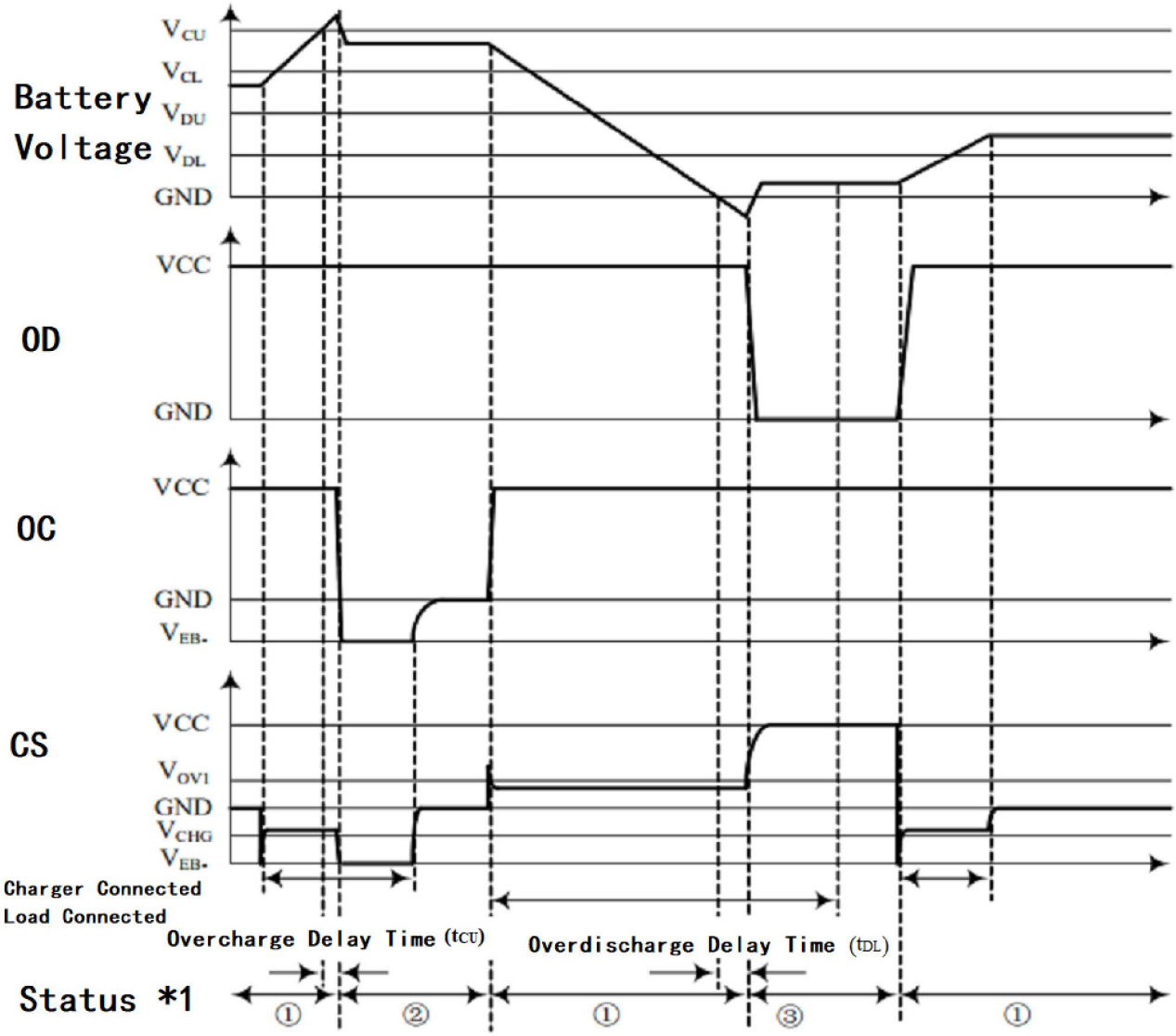




SYMBOL	ALL DIMENSIONS IN MILLIMETERS		
	MINIMUM	NOMINAL	MAXIMUM
A	-	1.30	1.40
A1	0	-	0.15
A2	0.90	1.20	1.30
b	0.30	-	0.50
b1	0.30	0.40	0.45
b2	0.30	0.40	0.50
c	0.08	-	0.22
c1	0.08	0.13	0.20
D	2.90 BSC		
E	2.80 BSC		
E1	1.60 BSC		
e	0.95 BSC		
e1	1.90 BSC		
L	0.30	0.45	0.60
L1	0.60 REF		
L2	0.25 BSC		
R	0.10	-	-
R1	0.10	-	0.25
θ	0°	4°	8°
θ1	5°	-	15°
θ2	5°	-	15°

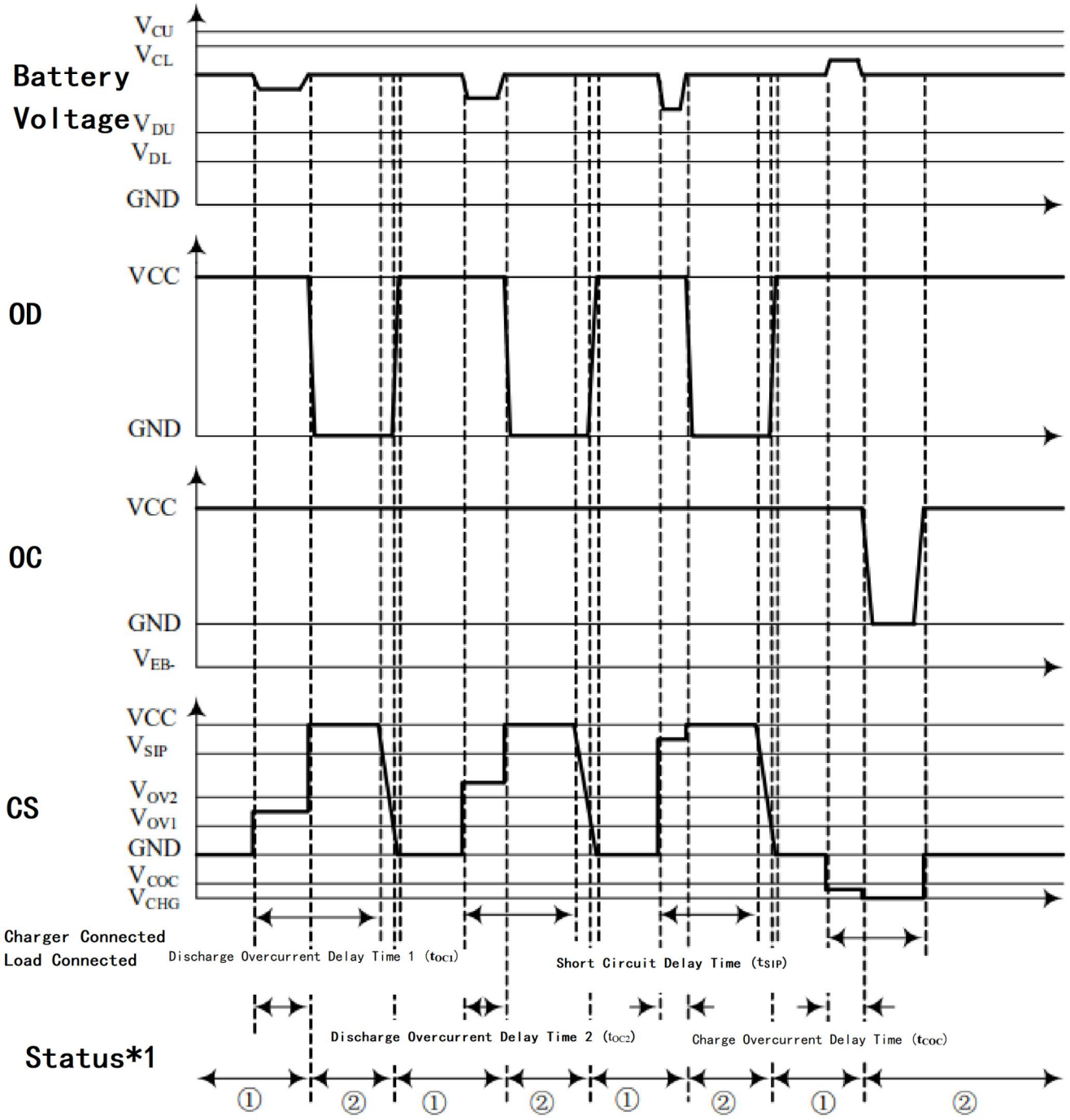
10. Working Sequence Diagram

10.1 Overcharge detection, over discharge detection



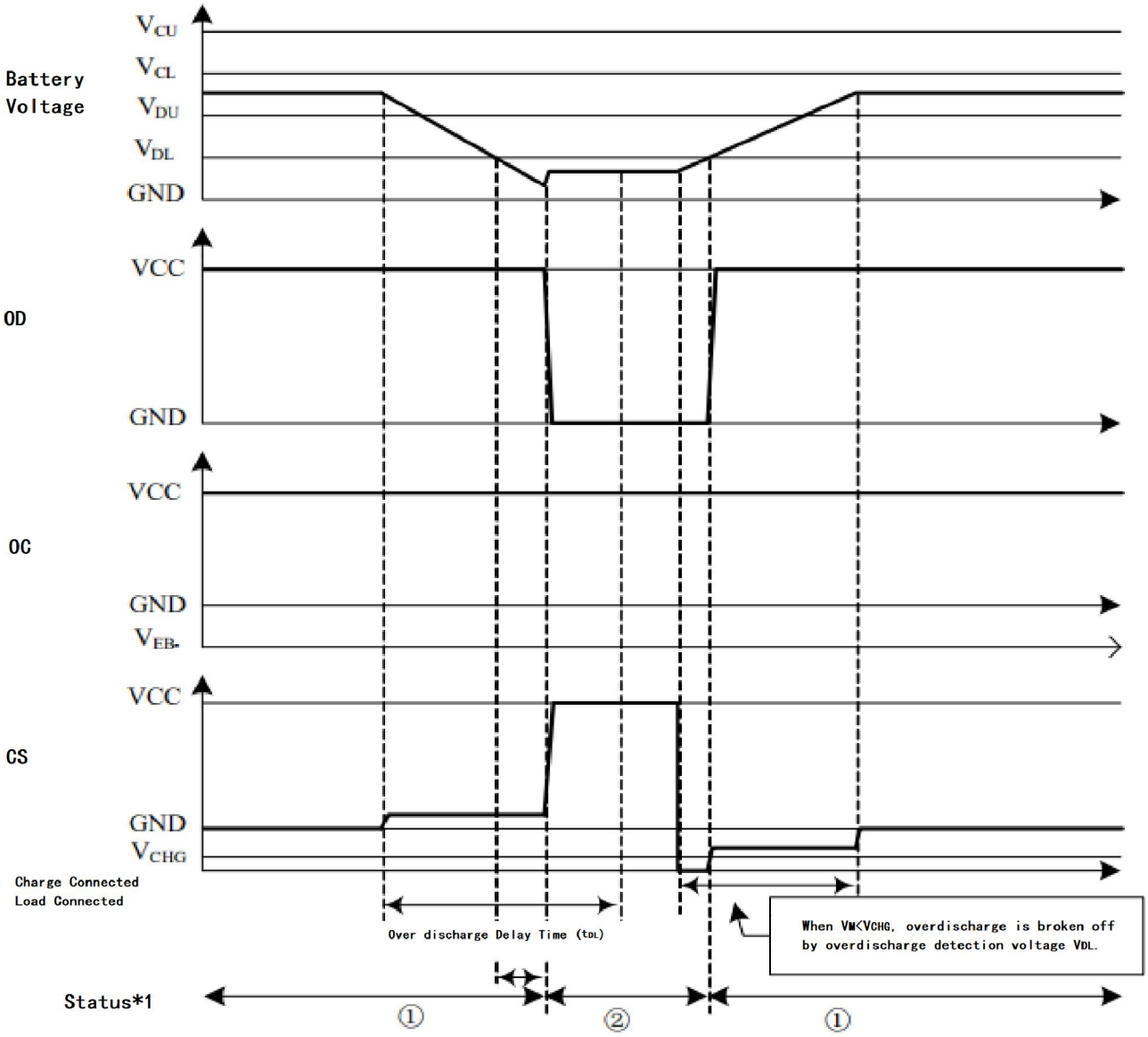
*1 1) Normal state
2) Overcharge status
3) Over discharge status

10.2 Discharge Overcurrent Detection / Charge Overcurrent Detection



*1 1) Normal state
2) Overcharge status
3) Over discharge status

10.3 Charger Detection



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