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

Description

- The SL8261D-G3JE incorporates a high-precision voltage detection circuit and delay circuit. It is a protection IC designed for single-cell lithium-ion/lithium-polymer rechargeable batteries. This IC is suitable for protecting against overcharging, over-discharging, overcurrent, and short-circuiting of a single-cell lithium-ion/lithium-polymer rechargeable battery. The overcharge detection voltage with a precision of ±25mV ensures safe and efficient charging while also featuring very low power consumption during operation.

- This IC utilizes a very small SOT23-6 package, making it highly suitable for rechargeable battery applications with strict space requirements.

Features

- High-precision voltage detection circuit
- Internal circuit sets all delay times (no external capacitors needed)
- Low power consumption
- Operating mode: typical value 3.0μA (V_{DD}=3.9V)
- Sleep mode: maximum value 0.1μA (V_{DD}=2.0V)
- Charger connection terminal is designed for high voltage tolerance
- Allows charging of 0V batteries
- Wide operating temperature range: -40°C to +85°C
- Small package: SOT23-6
- Lead-free and halogen-free green environmental product

Applications

- Single-cell lithium-ion rechargeable battery
- Single-cell lithium-polymer rechargeable battery

Product information

PN	Package
SL8261D-G3JE	SOT23-6

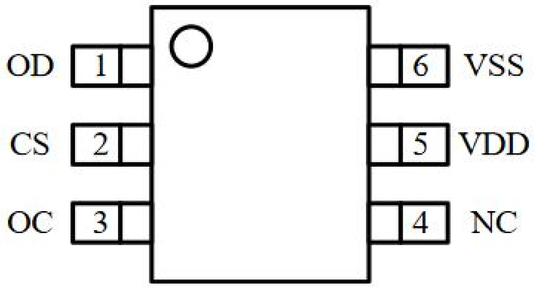
PN	Overcharge detection voltage	Overcharge release voltage	Over-discharge detection voltage	Over-discharge release voltage	Discharge overcurrent detection voltage	Discharge overcurrent 2 detection voltage	Charge overcurrent detection voltage	Functionality for charging 0V batteries	Sleep function /Overdischarge self-recovery function
	V_{CU}	V_{CR}	V_{DL}	V_{DR}	V_{DIP}	V_{DIP2}	V_{CIP}	Allowed /Forbidden	
SL8261D -G3JE	4.280V	4.080V	3.000V	3.000V	80mV	500mV	-200mV	Allowed	dormancy

Limiting parameters

Parameter	Symbol	Value	Unit
Voltage between V_{DD} and V_{SS}	V_{DD}	V_{SS}-0.3~V_{SS}+8	V
Voltage at OC output terminal	V_{OC}	V_{DD}-15~V_{DD}+0.3	V
Voltage at OD output terminal	V_{OD}	V_{SS}-0.3~V_{DD}+0.3	V
Voltage at CS input terminal	V_{CS}	V_{DD}-15~V_{DD}+0.3	V
Operating temperature range	T_{OP}	-40~+85	℃
Storage temperature range	T_{ST}	-40~+125	℃
Allowable power dissipation	P_D	250	mW

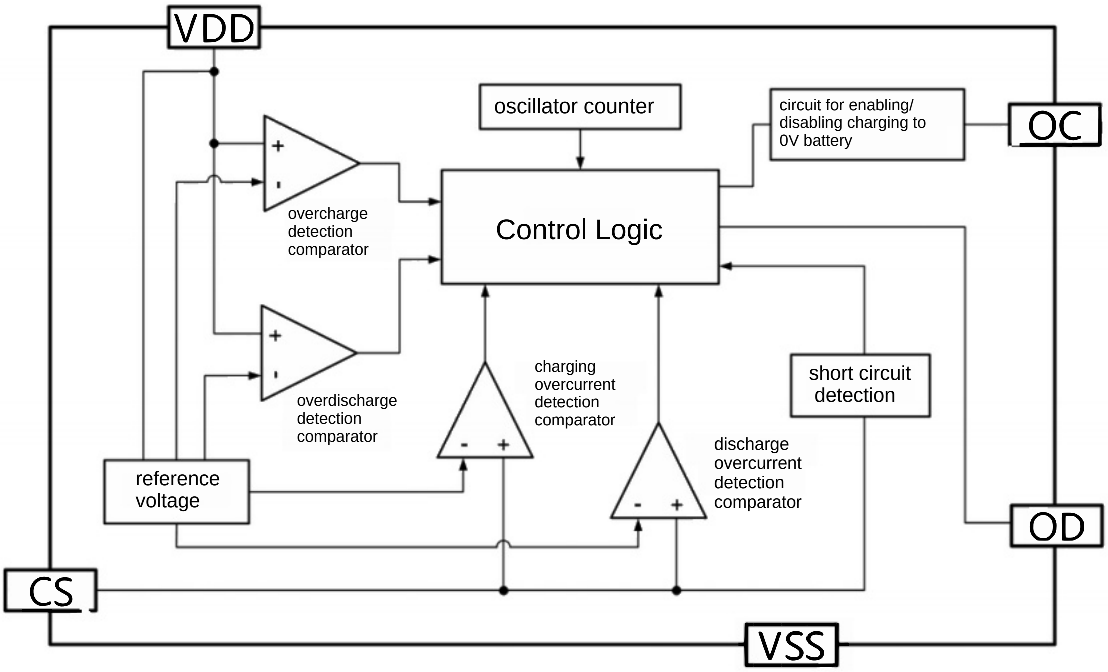
Note:
Exceeding the above "limiting parameters" may cause permanent damage to the device. The device can operate within the limiting parameter specifications, but its characteristics are not guaranteed. Operating the device for extended periods under limiting conditions may affect the device's reliability and lifespan.

Pin configuration and function



Pin number	Pin name	Function
1	OD	MOSFET gate connection terminal for discharge control
2	CS	Overcurrent detection input terminal, charger detection terminal child
3	OC	MOSFET gate connection terminal for charge control
4	NC	no connection
5	V_{DD}	Power supply, positive power input terminal
6	V_{SS}	Ground terminal, negative power input terminal

Internal block diagram



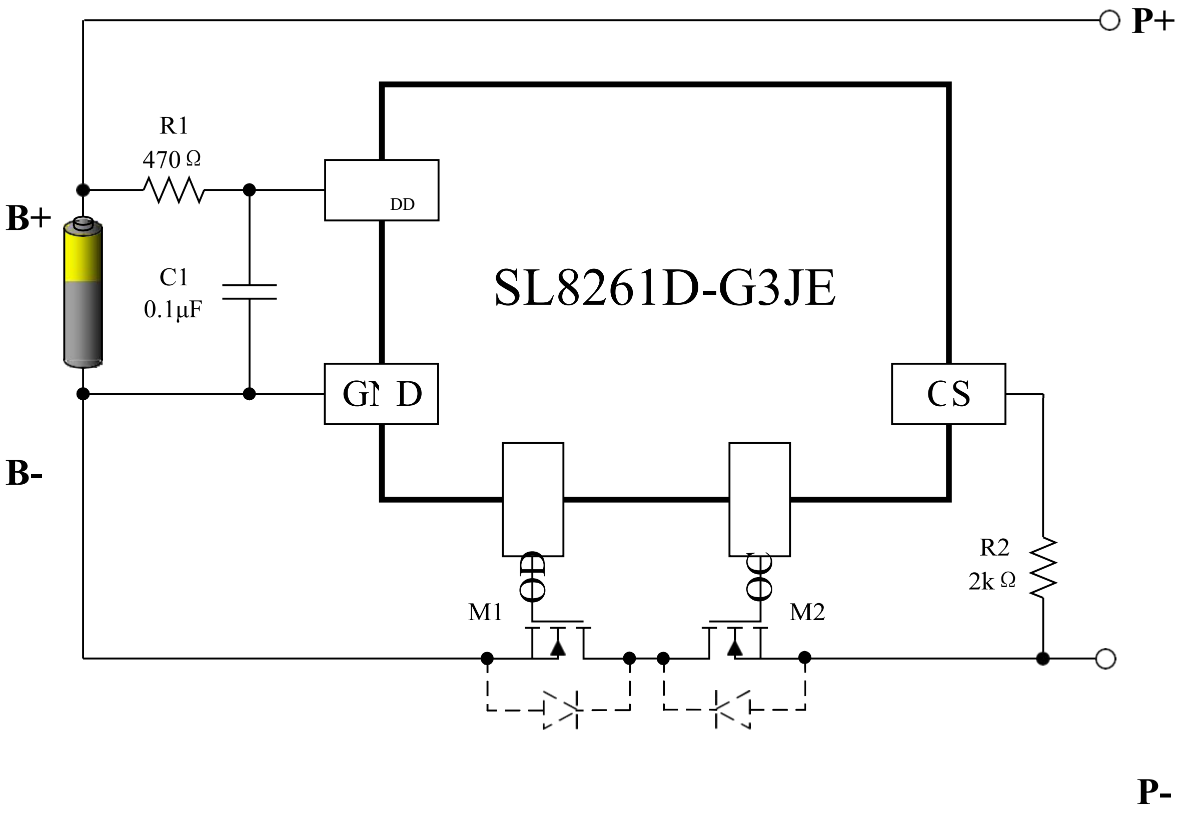
Electrical parameters (V_{SS}=0V, T_a=25℃, unless otherwise specified)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Detection voltage						
Overcharge detection voltage	V_{CU}		4.255	4.280	4.305	V
Overcharge release voltage	V_{CR}		4.030	4.080	4.130	V
Over-discharge detection voltage	V_{DL}		2.950	3.000	3.050	V
Over-discharge release voltage	V_{DR}		2.950	3.000	3.050	V
Discharge overcurrent detection voltage	V_{DIP}	V_{DD}=3.6V	65	80	95	mV
Discharge overcurrent 2 detection voltage	V_{DIP2}	V_{DD}=3.6V	400	500	600	mV
Load short-circuit detection voltage	V_{SIP}	V_{DD}=3.0V	0.550	0.850	1.150	V
Charge overcurrent detection voltage	V_{CIP}	V_{DD}=3.6V	-250	-200	-150	mV
Input voltage						
V_{DD}-V_{SS} Operating voltage	V_{DSOP1}	-	1.5	-	5.5	V
V_{DD}-C_S Operating voltage	V_{DSOP2}	-	1.5	-	17	V
Quiescent current						
Operating current	I_{DD}	V_{DD}=3.9V	-	3	6	μA
Over-discharge current	I_{OD}	V_{DD}=2.0V	-	-	0.1	μA
Delay time parameters						
Overcharge detection delay time	T_{OC}	V_{DD}=3.9V→4.5V	900	1200	1500	ms
Over-discharge detection delay time	T_{OD}	V_{DD}=3.6V→2.0V	115	145	175	ms
Discharge overcurrent detection delay time	T_{DIP}	V_{DD}=3.6V,CS=0.4V	6	8	10	ms
Discharge overcurrent 2 detection delay time	T_{DIP2}	V_{DD}=3.6V,CS=0.6V	0.8	1.0	1.2	ms
Charge overcurrent detection delay time	T_{CIP}	V_{DD}=3.6V,CS=-0.3V	6	8	10	ms
Load short-circuit detection delay time	T_{SIP}	V_{DD}=3.0V,CS=1.3V	200	300	400	μs
Control terminal output voltage						
OD terminnal output high voltage	V_{DH}		V_{DD}-0.1	V_{DD}-0.02	-	V
OD terminal output low voltage	V_{DL}		-	0.1	0.5	V
OC terminal output high voltage	V_{CH}		V_{DD}-0.1	V_{DD}-0.02	-	V
OC terminal output low voltage	V_{CL}		-	0.1	0.5	V
Charging 0V battery function						
OV charging	V_{oCH}		1.2	-	-	V

(V_{SS}=0V, T_a=-20~60℃, unless otherwise specified)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Detection voltage						
Overcharge detection voltage	V_{CU}		4.225	4.280	4.320	V
Overcharge release voltage	V_{CR}		4.000	4.080	4.160	V
Over-discharge detection voltage	V_{DL}		2.920	3.000	3.080	V
Over-discharge release voltage	V_{DR}		2.920	3.000	3.080	V
Discharge overcurrent detection voltage	V_{DIP}	V_{DD}=3.6V	50	80	110	mV
Discharge overcurrent 2 detection voltage	V_{DIP2}	V_{DD}=3.6V	400	500	600	mV
Load short-circuit detection voltage	V_{SIP}	V_{DD}=3.0V	0.250	0.850	1.350	V
Charge overcurrent detection voltage	V_{CIP}	V_{DD}=3.6V	-250	-200	-150	mV
Input voltage						
V_{DD}-V_{SS} Operating voltage	V_{DSOP1}	-	1.5	-	5.5	V
V_{DD}-C_S Operating voltage	V_{DSOP2}	-	1.5	-	17	V
Quiescent current						
Operating current	I_{DD}	VDD=3.9V	-	3	6	μA
Over-discharge current	I_{OD}	VDD=2.0V	-	-	0.1	μA
Delay time parameters						
Overcharge detection delay time	T_{OC}	V_{DD}=3.9V→4.5V	700	1200	1700	ms
Over-discharge detection delay time	T_{OD}	V_{DD}=3.6V→2.0V	90	145	200	ms
Discharge overcurrent detection delay time	T_{DIP}	V_{DD}=3.6V,C_S=0.4V	4	8	12	ms
Discharge overcurrent 2 detection delay time	T_{DIP2}	V_{DD}=3.6V,C_S=0.6V	0.7	1.0	1.3	ms
Charge overcurrent detection delay time	T_{CIP}	V_{DD}=3.6V,C_S=-0.3V	4	8	12	ms
Load short-circuit detection delay time	T_{SIP}	V_{DD}=3.0V,C_S=1.3V	150	300	450	μs
Control terminal output voltage						
OD terminal output high voltage	V_{DH}		V_{DD}-0.1	V_{DD}-0.02	-	V
OD terminal output low voltage	V_{DL}		-	0.1	0.5	V
OC terminal output high voltage	V_{CH}		V_{DD}-0.1	V_{DD}-0.02	-	V
OC terminal output low voltage	V_{CL}		-	0.1	0.5	V
Charging 0V battery function						
OV charging	V_{0CH}		1.7	-	-	V

Typical application



Remarking	Component Name	Purpose	Min	Typical	Max	Notes
R1	Resistor	Limiting current, stabilizing V_{DD}, enhancing ESD	100Ω	470Ω	470Ω	*1
R2	Resistor	Limiting current	1kΩ	2kΩ	2kΩ	*2
C1	Capacitor	Filtering, stabilizing V_{DD}	0.01µF	0.1µF	1.0µF	*3
M1	N-MOSFET	Discharge control	-	-	-	*4
M2	N-MOSFET	Charge control	-	-	-	*5

*1: Connecting a resistor with a larger resistance may cause a voltage drop across R1 due to the quiescent current, affecting the accuracy of the detection voltage. When the charger is reversed, the current flows from the charger to the IC. If R1 is too large, it may cause the voltage between the V_{DD}-V_{SS} terminals to exceed the absolute maximum rating. *2: Connecting a resistor with a larger resistance may prevent the current from being cut off when a high voltage charger is connected. However, to control the current when the charger is reversed, please choose a larger resistance value as much as possible. *3: C1 has the function of stabilizing the VDD voltage. Please do not connect a capacitor below 0.01µF. *4: If the threshold voltage of the MOSFET is above the over-discharge detection voltage, it may stop discharging before the over-discharge protection. *5: If the voltage between the gate and source of the N-MOSFET is below the charger voltage, the N-MOSFET may be damaged. Note: The above parameters may be changed without notice. Please contact the sales department in time to obtain the latest version of the specifications. If the peripheral components need to be adjusted, it is recommended that customers conduct sufficient evaluation and test.

Functional description

Normal Operation State

This IC continuously monitors the battery voltage connected between V_{DD} and V_{SS}, as well as the voltage difference between CS and VSS, to control charging and discharging. When the battery voltage is above the over-discharge detection voltage (V_{DL}) and below the overcharge detection voltage (V_{CU}), and the CS terminal voltage is above the charge overcurrent detection voltage (V_{CIP}) and below the discharge overcurrent detection voltage (V_{DIP}), the IC's OC and OD terminals both output a high level, causing the charge control MOSFET and discharge control MOSFET to conduct simultaneously. This state is called the "normal operation state." In this state, both charging and discharging can proceed freely.

Note: When the battery cell is first connected, there may be a possibility that it cannot be discharged. At this time, shorting the CS terminal and the VSS terminal, or connecting a charger, can restore the normal operation state.

Overcharge State

In the normal operation state, during the charging process, once the battery voltage exceeds the overcharge detection voltage (V_{CU}), and this state lasts for more than the overcharge detection delay time (T_{OC}), the IC will close the charge control MOSFET (OC terminal), stopping the charging. This state is called the "overcharge state." In the absence of a charger, the overcharge state can be released in the following two situations:

- Due to self-discharge, the battery voltage drops below the overcharge release voltage (V_{CR}), and the overcharge state is released, returning to the normal operation state.
- Connecting a load for discharge, the discharge current first passes through the parasitic diode of the charge control MOSFET. When the CS terminal voltage is above the discharge overcurrent detection voltage (V_{DIP}) and the battery voltage drops below the overcharge detection voltage (V_{CU}), the overcharge state is released, returning to the normal operation state.

Note: A battery that has entered the overcharge state, if still connected to the charger, cannot release the overcharge state even if the battery voltage is lower than the overcharge release voltage (V_{CR}). Disconnect the charger, and when the CS terminal voltage rises above the charge overcurrent detection voltage (V_{CIP}), the overcharge state can be released.

Over-discharge State

In the normal operation state, during the discharging process, when the battery voltage drops below the over-discharge detection voltage (V_{DL}), and this state lasts for more than the over-discharge detection delay time (T_{OD}), the IC will close the discharge control MOSFET (OD terminal), stopping the discharging. This state is called the "over-discharge state," and the IC enters the sleep state. The release of the over-discharge state has the following two methods:

- Connect a charger. If the CS terminal voltage is below the charge overcurrent detection voltage (V_{CIP}), when the battery voltage is above the over-discharge detection voltage (V_{DL}), the over-discharge state is released, returning to the normal operation state.
- Connect a charger. If the CS terminal voltage is above the charge overcurrent detection voltage (V_{CIP}), when the battery voltage is above the over-discharge release voltage (V_{DR}), the over-discharge state is released, returning to the normal operation state.

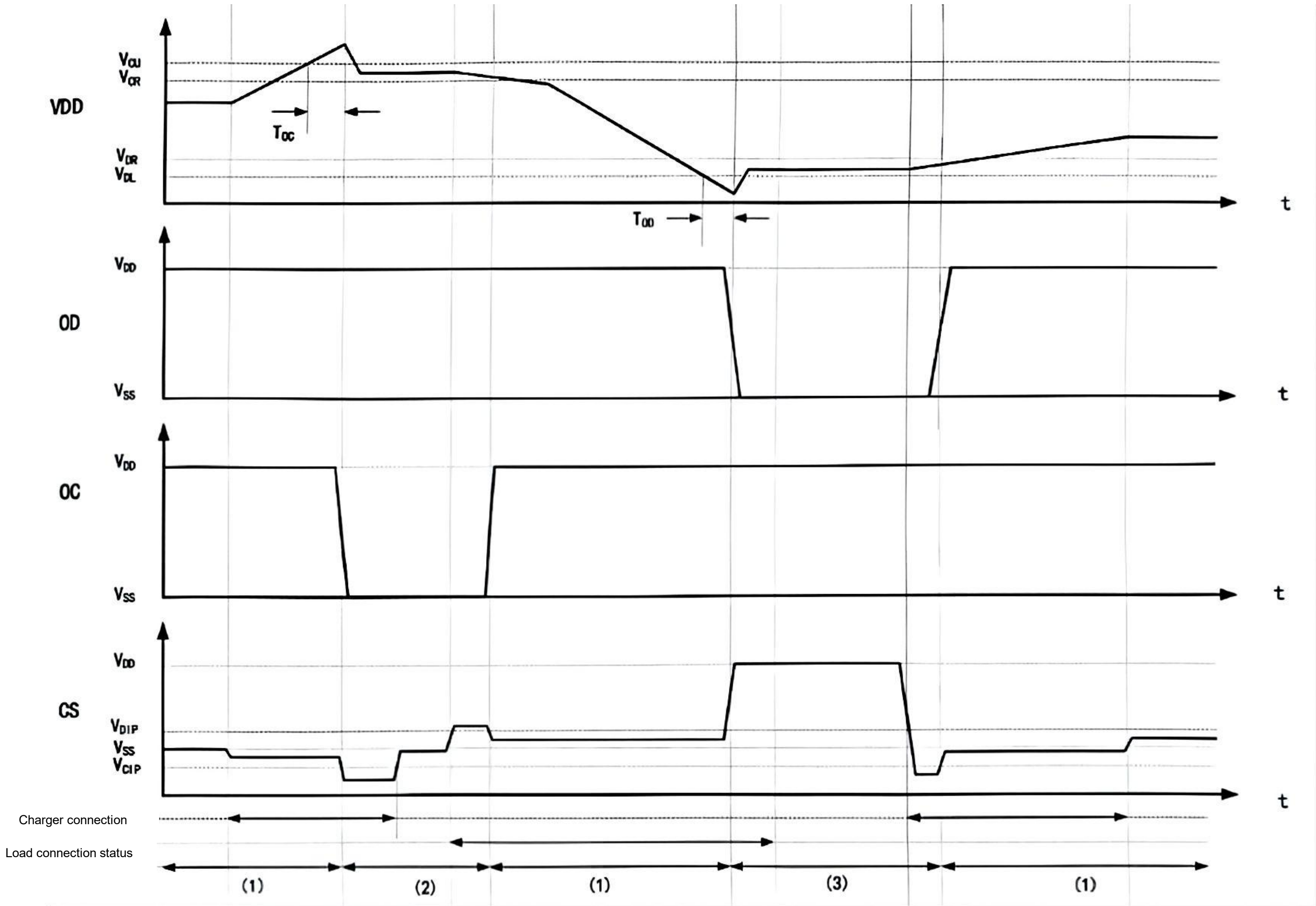
Discharge Overcurrent State (Discharge Overcurrent Detection Function and Load Short-circuit Detection Function)

In the normal operation state, the IC continuously detects the discharge current by monitoring the voltage at the CS terminal. Once the CS terminal voltage exceeds the discharge overcurrent detection voltage (V_{DIP}), and this state lasts for more than the discharge overcurrent detection delay time (T_{DIP}), the discharge control MOSFET (OD terminal) is closed, stopping the discharging. This state is called the "discharge overcurrent state." Also, once the CS terminal voltage exceeds the load short-circuit detection voltage (V_{SIP}), and this state lasts for more than the load short-circuit detection delay time (T_{SIP}), the discharge control MOSFET (OD terminal) is also closed, stopping the discharging. This state is called the "load short-circuit state."

When the impedance connected between PB+ and PB- is greater than the discharge overcurrent/load short-circuit release impedance (typical value about 200kΩ), the discharge overcurrent state and load short-circuit state are released, returning to the normal operation state. Additionally, even if the impedance between PB+ and PB- is less than the discharge overcurrent/load short-circuit release impedance, when a charger is connected and the CS terminal voltage drops below the discharge overcurrent

Timing Diagrams

Overcharge Detection, Over-discharge Detection

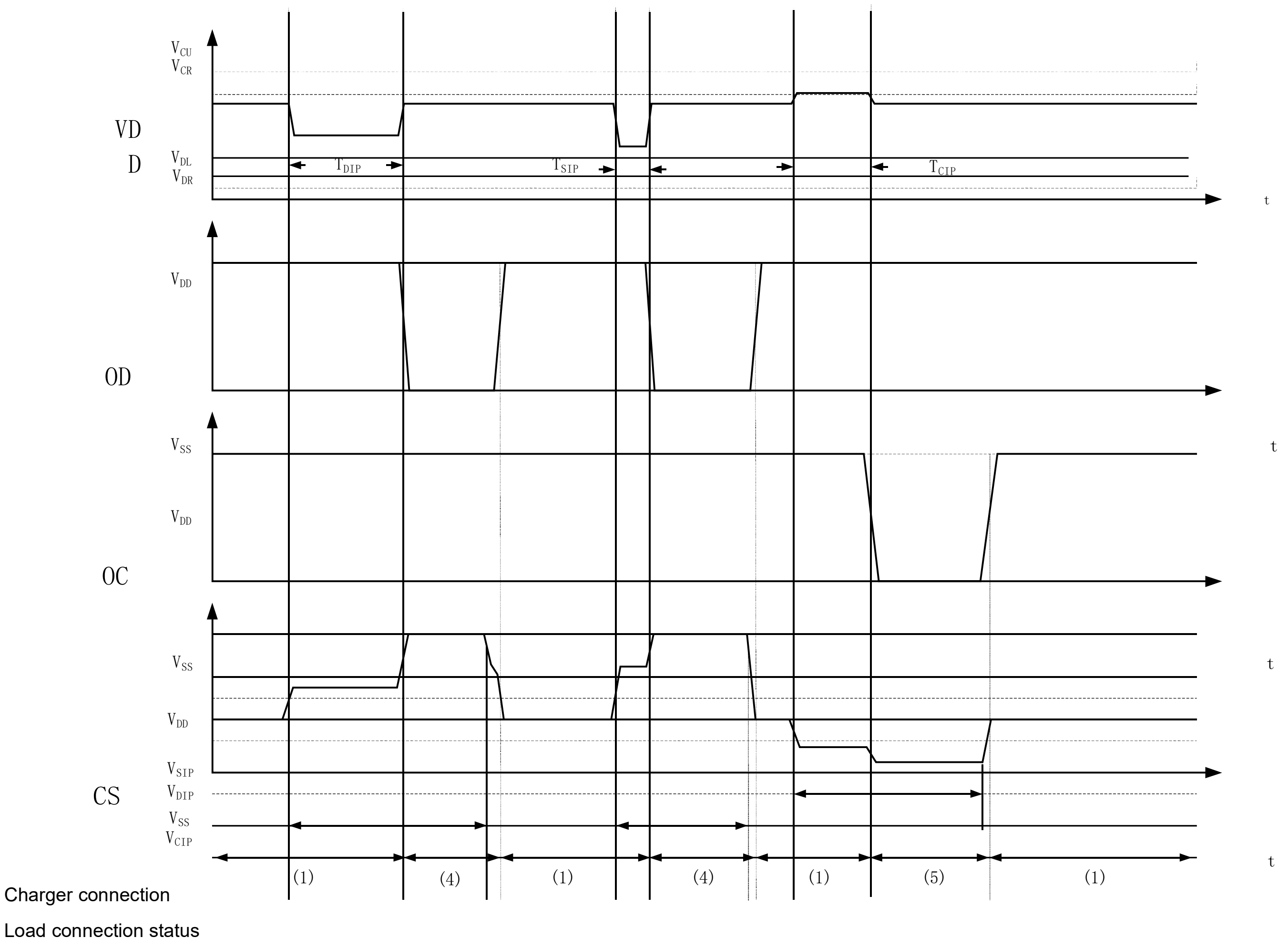


Note:
(1) Means Normal operation state
(2) Means Overcharge state
(3) Means Over-discharge state

Note:

- Overcharge release condition: $V_{CS} > V_{DIP}$ & $V_{DD} < V_{CU}$.
- Over-discharge release condition: $V_{CS} < V_{CIP}$ & $V_{DD} > V_{DL}$.

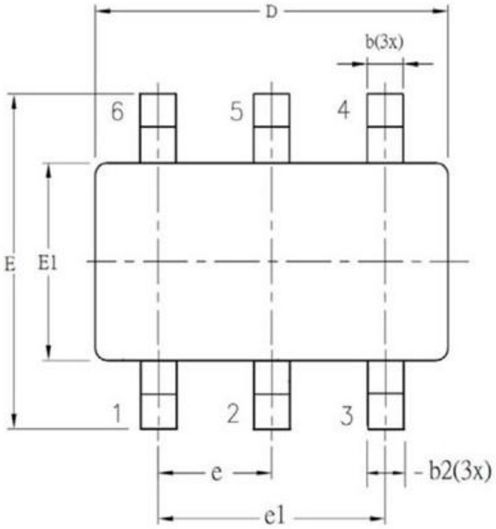
Discharge Overcurrent Detection, Load Short-circuit Detection, Charge Overcurrent Detection

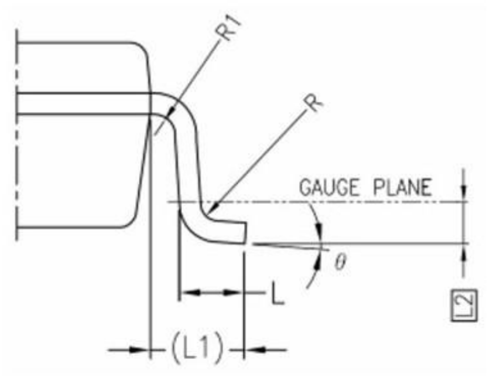


Note:
(1) Means Normal operation state
(4) Means Discharge overcurrent and load short-circuit state
(5) Means Charge overcurrent state

Package Outline

SOT-23-6 (unit: mm)





SYM BOL	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°