FH3016DCH+ One-Cell Li-Ion/Polymer Battery Protection IC

■ Description

The FH3016DCH+ is a protection IC for lithium-ion/lithium-polymer rechargeable batteries and includes high-accuracy voltage detection circuits and delay circuits. The overcharge, over discharge, discharging and charging overcurrent protection of the rechargeable one-cell lithium-ion or lithium-polymer battery can be detected.

■ Features

1) **High accuracy voltage detection**

• Overcharge detection voltage	4.400 V	Accuracy ±25 mV
• Overcharge release voltage	4.200 V	Accuracy ±50 mV
• Over discharge detection voltage	2.800 V	Accuracy ±50 mV
• Over discharge release voltage	3.000 V	Accuracy ±100 mV
• Discharging overcurrent detection voltage	0.150 V	Accuracy ±10 mV
• Short-circuit detection voltage	0.500 V	Accuracy ±100 mV
• Charging overcurrent detection voltage	-0.150 V	Accuracy ±15 mV

2) **Charger & Load Detection function**

3) **0V battery charge function** Available

4) **Power-down function** Unavailable

5) **Release condition of discharge overcurrent status** Load disconnection

6) **Discharge overcurrent release voltage** V_{DIOV}

7) **Ultra-low power dissipation**

• Normal mode	1.5 μA (Typ.)	(Ta = +25°C)
• Over discharge mode	0.5 μA (Typ.)	(Ta = +25°C)

8) **PB-Free, HF**

■ Application

• Lithium-ion/lithium-polymer rechargeable battery

■ Application

Figure 1 FH3016DCH+ (SOT23-6) Package silk screen and pin arrangement

Silk screen description:

1：Xinfeihong Logo。

1：**DCH** Three characters are the abbreviation of the product FH3016DCH+model。

1：The points above and below the three characters of DCH are the internal information of the product, and the quantity and position may change。

■ Pin Functions

Pin	Abbr	Desc
1	DO	Discharge control terminal connected with MOSFET gate
2	VM	Over currentdetectioninputterminal,chargerdetectionterminal
3	CO	The charging control is connected to the terminals with a MOSFET gate
4	NC	Not connected
5	VDD	Power terminal, positive power input terminal
6	VSS	Ground terminal, negative power input terminal

Table 1

■ Block Diagram

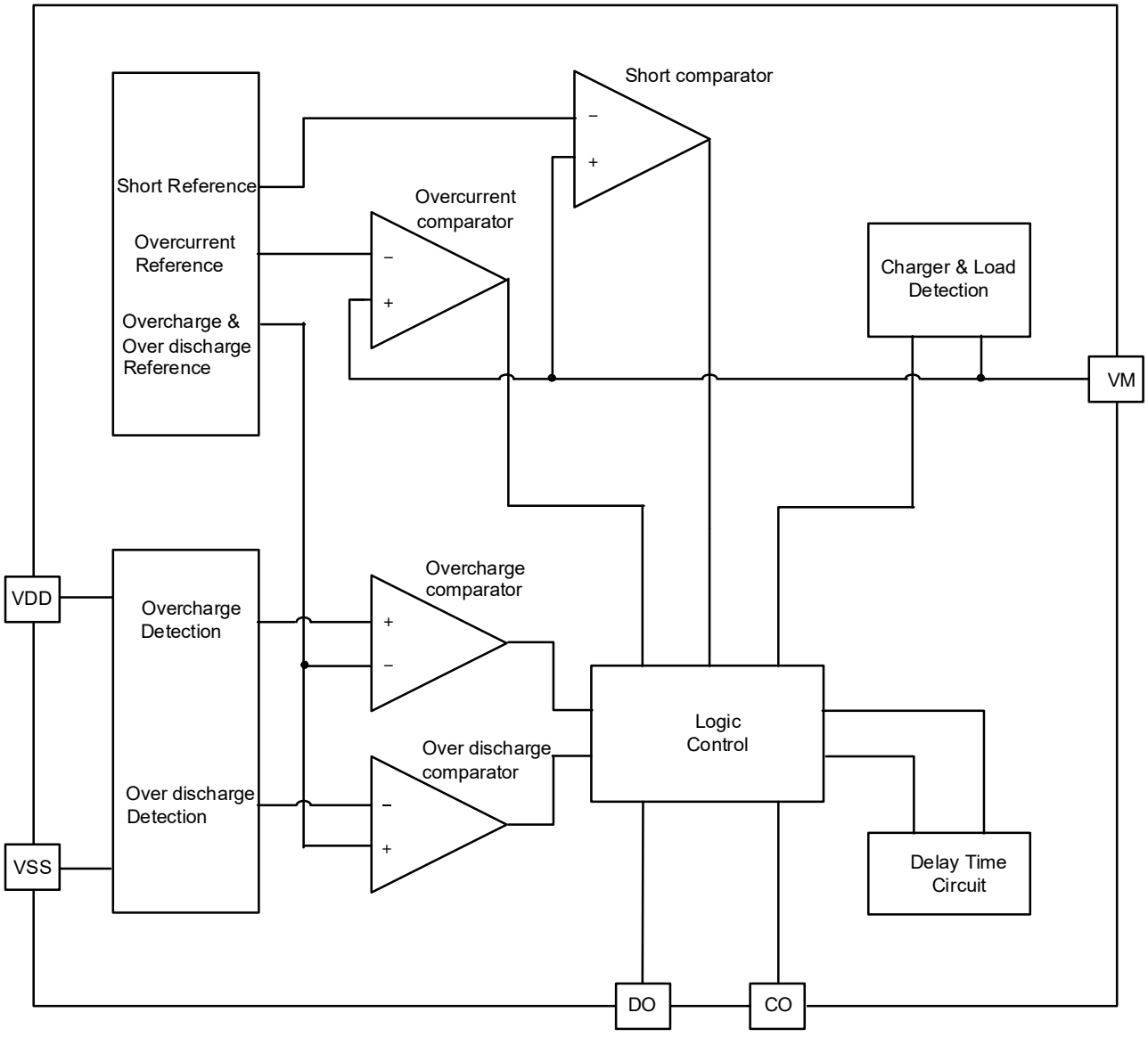


Figure 2

■ Products Catalogue

1. Detect Voltage List

Part No.	Overcharge detection voltage [V_{OC}]	Over-charge release voltage [V_{OCR}]	Over-discharge detection voltage [V_{OD}]	Over-discharge release voltage [V_{ODR}]	Discharge overcurrent detection [V_{EC}]	Short-circuit current detection [V_{SHORT}]	Charge overcurrent detection [V_{CHA}]
FH3016DCH+	4.400 V	4.200 V	2.800 V	3.000 V	0.150 V	0.500 V	-0.150 V

Table 2

2. Product Function List

Part No.	0 V Battery Charge Function	Release condition of discharge overcurrent status	Release Voltage of Discharge Overcurrent Status	Overcharge self-release Function	Power-down Function
FH3016DCH+	Available	Load disconnection	V_{DIOV}	Unavailable	Unavailable

Table 3

3. Delay Time

Overcharge detection delay time T_{OC}	**Over discharge detection delay time T_{OD}**	**Discharge overcurrent detection delay time T_{EC}**	**Charge overcurrent detection delay time T_{CHA}**	**Load short-circuiting detection delay time T_{SHORT}**
1000 ms	128 ms	8 ms	8 ms	280 μs

Table 4

■ Absolute Maximum Ratings

(Unless otherwise specified: Ta = +25°C)

Item	Symbol	Ratings	Unit
Power supply voltage	VDD	VSS-0.3 ~ VSS+8.0	V
Input pin voltage for VM	V_{VM}	VDD-28 ~ VDD+0.3	V
CO output voltage	V_{CO}	V_{VM} -0.3 ~ VDD+0.3	V
DO output voltage	V_{DO}	VSS-0.3 ~ VDD+0.3	V
Operating temperature	T_{OPR}	-40 ~ +85	°C
Storage temperature	T_{STG}	-55 ~ +125	°C

Table 5

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded in any conditions.

■ Electrical Characteristics

(Unless otherwise specified:Ta = +25°C)

Item		Symbol	Test conditions	Min.	Typ.	Max.	Unit
Power supply voltage		VDD	-	1.0	-	7.5	V
Operating consumption		I_{VDD}	VDD=3.5V	0.9	1.5	3.0	μA
Over-discharge consumption		I_{OPED}	VDD =1.5V	-	0.5	0.8	μA
Overcharge	detection voltage	V_{OC}	VDD =3.5→4.8V	4.375	4.400	4.425	V
	release voltage	V_{OCR}	VDD =4.8→3.5V	4.150	4.200	4.250	V
	detection delay time	T_{OC}	VDD =3.5→4.8V	700	1000	1300	ms
	detection release delay time	T_{OCR}	VDD =4.8→3.5V	0.5	1.0	1.5	ms
Over discharge	detection voltage	V_{OD}	VC5=3.5→2.0V	2.750	2.800	2.850	V
	release voltage	V_{ODR}	VDD =2.0→3.5V	2.900	3.000	3.100	V
	detection delay time	T_{OD}	VDD =3.5→2.0V	89.6	128	166.4	ms
	detection release delay time	T_{ODR}	VDD =2.0→3.5V	0.5	1.0	1.5	ms
Discharge overcurrent	detection voltage	V_{EC}	VM-VSS=0→0.20V	0.140	0.150	0.160	V
	detection delay time	T_{EC}	VM-VSS=0→0.20V	5.6	8	10.4	ms
	detection release delay time	T_{ECR}	VM-VSS=0.20→0V	0.5	1.0	1.5	ms
Charge overcurrent	detection voltage	V_{CHA}	VSS-VM=0→0.30V	-0.165	-0.150	-0.135	V
	detection delay time	T_{CHA}	VSS-VM=0→0.30V	5.6	8	10.4	ms
	detection release delay time	T_{CHAR}	VSS-VM=0.30→0V	0.5	1.0	1.5	ms
Short circuit	detection voltage	V_{SHORT}	VM -VSS=0→1.5V	0.400	0.500	0.600	V
	detection delay time	T_{SHORT}	VM -VSS=0→1.5V	140	280	504	μs
	detection release delay time	T_{SHORTR}	VM -VSS=1.5→0V	0.5	1.0	1.5	ms
0 V battery charge “Available” starting charge voltage		V_{0CH}	0 V battery charging “Available”	0.0	0.7	1.5	V

Table 6

■ Function Description

1. Normal Condition

The FH3016DCH+ monitors the voltage of the battery connected between VDD pin and VSS pin, the voltage between VM pin and VSS pin to control charging and discharging. When the battery voltage is in the range from the over discharge detection voltage (V_{OD}) to the overcharge detection voltage (V_{OC}), and the VM pin voltage is in the range from charging overcurrent detection voltage (V_{CHA}) to discharging overcurrent detection voltage (V_{EC}), the IC turns both the charging and discharging control MOSFETs on. This status is called the normal condition.

Note: When connecting the cell for the first time, there will be the possibility of not discharging. At this time, short connect the VM pin and VSS pin, or connect the charger, can be restored to normal working condition.

2. Overcharge Condition

During charging, when the battery voltage connected between VDD and VSS pins exceeds the charging protection voltage (V_{OC}) and this state lasts for longer than the charging protection delay time (T_{OC}), the output voltage of IC CO pin changes from high level to low level, and the MOSFET used for charging control is turned off, charging is stopped. This status is called the overcharge condition.

The overcharge protection state will be released if any of the next conditions occurs:

(1) 0V< VM < V_{EC}, When the battery voltage is reduced to below the overcharge relief voltage (V_{OCR}) due to self-discharge, the overcharge state is released and the battery returns to the normal working state.

(2) VM> V_{EC} (connecting to the load), When the battery voltage is lower than V_{OC}, the overcharge state is released and the battery returns to the normal working state.

Caution: When a charger is connected after overcharge detection, the overcharge status is not released even if the battery voltage is below V_{OCR}. The overcharge status is released when the VM pin voltage goes over V_{CHA} (typ.) by removing the charger.

3. Over discharge Condition

During discharging, If the voltage difference between the VDD pin and the VM pin drops below 0.1V (Typ), the current consumed is reduced to the current consumed during power down (I_{OPED}). During discharging, the over discharge state can be released in the following three cases:

（1） Connecting to the charger VM ≤ 0V(Typ), when the battery voltage is higher than V_{OD}.

（2） Connecting to the charger (0V(Typ) < VM < 0.7V), when the battery voltage is higher than V_{ODR}.

（3） Disconnect the charger, VM ≥ 0.7V(Typ), when the battery voltage is higher than V_{ODR}.

4. Discharging Overcurrent Condition

During discharging, the voltage of VM becomes higher with the current increasing. When the voltage of VM is higher than V_{EC} and stays longer than T_{EC}, the discharge MOSFET will be turned off and stop discharging, this status is called the discharging overcurrent condition.

If VM pin voltage is higher than short-circuit voltage and stays longer than T_{SHORT}, The MOSFET will be turned off and stop discharging. This status is called the load short circuit condition.

The release condition of discharge overcurrent status is “disconnect load” and discharge overcurrent release voltage “V_{DIOV}”.

When discharge overcurrent status, The VM pin inside the IC is connected to the VSS pin by R_{VMS} resistance, during the connection load, The VM pin voltage changes to the VDD pin voltage because it is connected to the load. If disconnected with the load, The VM pin returns to the VSS pin voltage. When the VM pin voltage drops below V_{DIOV}, the discharge overcurrent status can be released.

5. Charging Overcurrent Condition

During charging, If the VM pin voltage falls below the charging overcurrent detection voltage (V_{CHA}) and stays longer than the charging overcurrent detection delay time (T_{CHA}) or longer, the charging control MOSFET turns off and charging stops. This status is called the charging overcurrent condition.

Note: The discharging voltage of charging overcurrent is 0V(Typ). If the charging overcurrent can be removed reliably, the voltage of VM pin needs ≥ 0.01V. After the actual charging overcurrent protection occurs, If disconnect the charger or connect the load, the VM pin will be pulled up by R_{VMC}. The voltage of the VM pin must be higher than 0.01V, and the overcurrent state of charging is removed and the VM pin will return to the normal working state.

6. 0 V Battery Charging Function "Available"

When the 0 V battery charge starting charger voltage (V_{0CHA}) or higher is applied between P+ pin and P− pin by connecting a charger, the charging control MOSFET gate is fixed to VDD pin voltage. When the voltage between the gate and 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 start charging.

Note: The discharging voltage of charging overcurrent is 0V(Typ.). If the charging overcurrent can be removed reliably, the voltage of VM pin needs ≥ 0.01V. After the actual charging overcurrent protection occurs, if disconnect the charger or connect the load, the VM pin will be pulled up by R_{VMC}. The voltage of the VM pin must be higher than 0.01V, and the overcurrent state of charging is removed and the VM pin will return to the normal working state.

■ Application Circuits

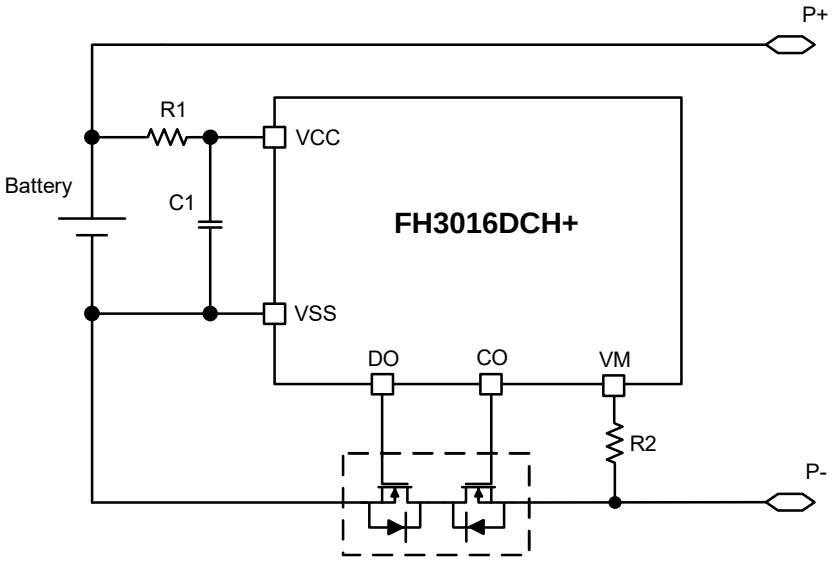


Figure 3

Component Symbol	Type	Range	Unit
R1	470	470 ~ 1500	Ω
C1	0.1	0.047 ~ 0.220	μF
R2	2	1 ~ 3	kΩ

Table 7

Caution:

1. The above constants may be changed without notice.

2. The example of connection shown above and the constant do not guarantee proper operation. Perform thorough evaluation using the actual application to set the constant.

Operation Timing Chart

1. Overcharge and Charging Overcurrent Detection

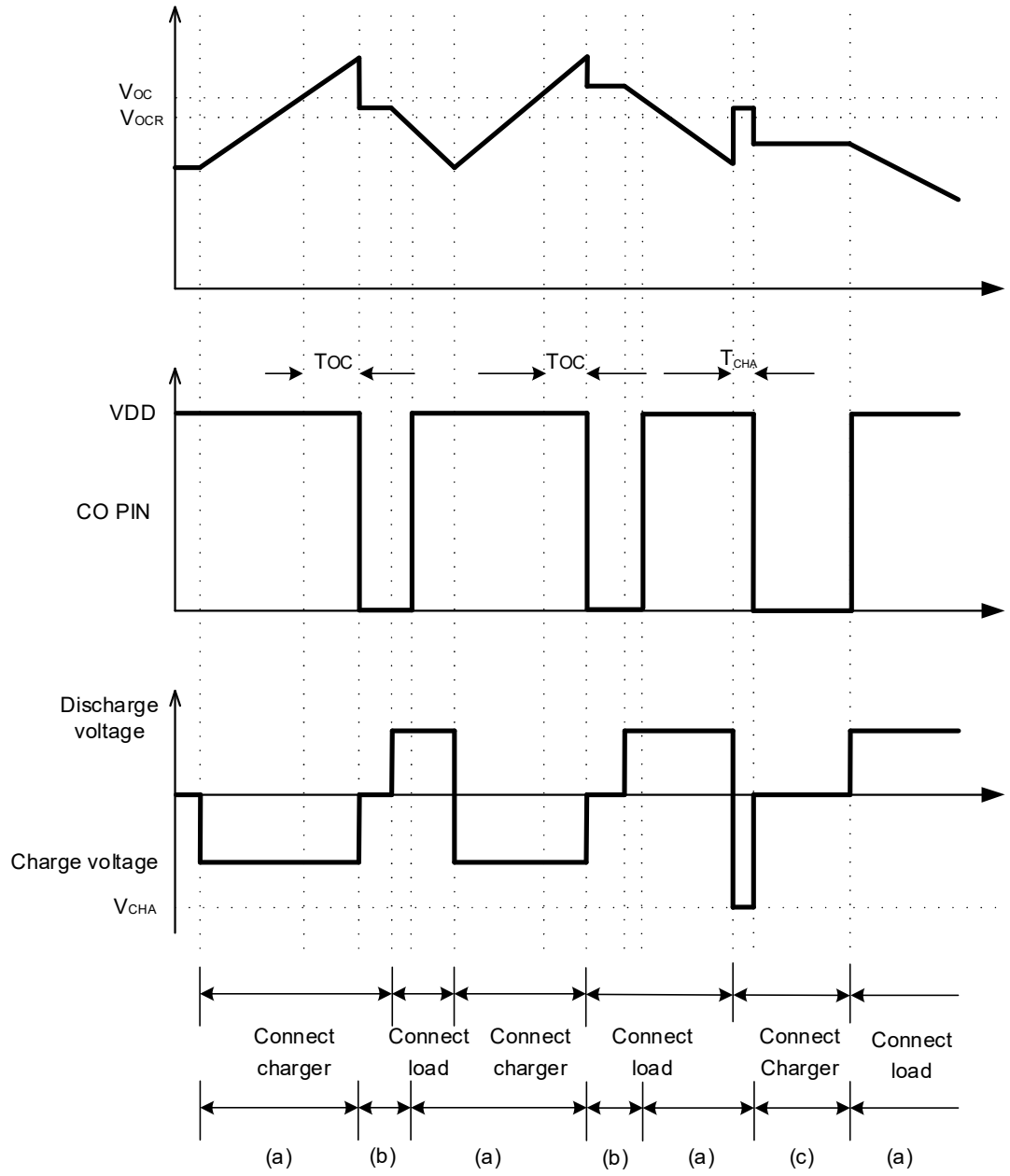


Figure 4

(a) Normal condition

(b) Overcharge condition

(c) Charging overcurrent condition

2. Over discharge and discharging Overcurrent Condition Detection

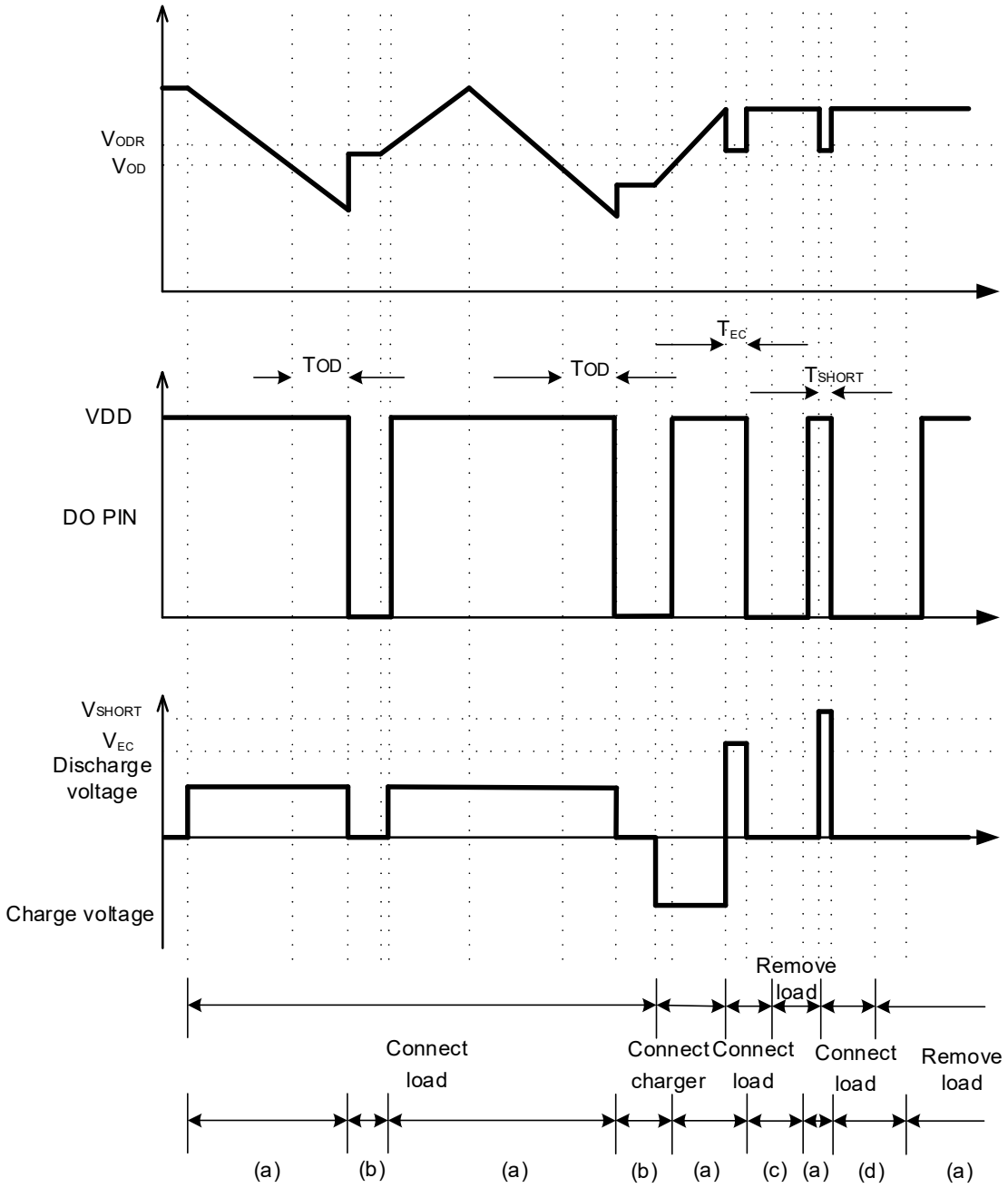


Figure 5

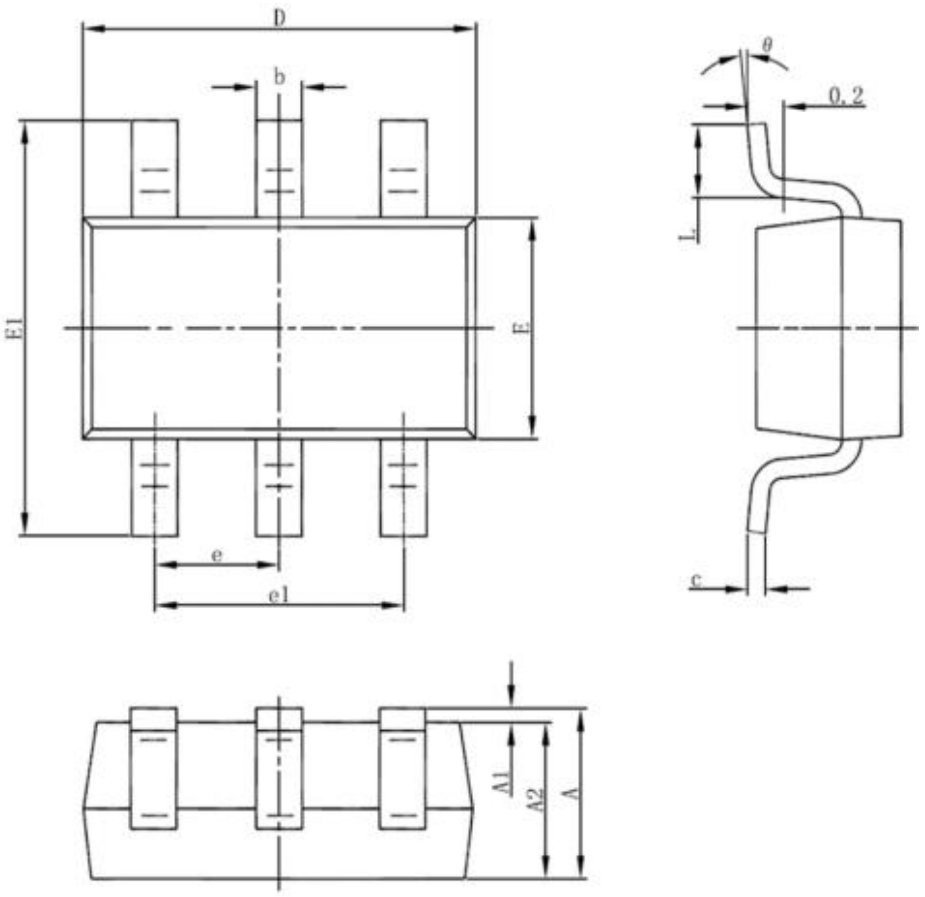
(a) Normal condition

(b) Over discharge condition

(c) Discharging overcurrent condition

(d) Load short circuit

Package Information : SOT23-6



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.750	3.150	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.500	3.100	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°