Single-Cell Li-Ion and Li-Polymer Battery Protector with Temperature Protection Function

1 Features

- **Voltage Detection:**
  - ✧ Overcharge protection voltage (V_{OV}): 3.400V~4.800V(Step:5mV), accuracy: ±15mV
  - ✧ Overcharge release voltage (V_{OVR}): 3.100V~4.800V[note1] ,accuracy: ±30mV
  - ✧ Overdischarge protection voltage (V_{UV}): 2.000V~3.200V(Step:10mV),accuracy: ±30mV
  - ✧ Overdischarge release voltage (V_{UVR}): 2.200V~3.400V[note2],accuracy: ±50mV
- **Current Detection:**
  - ✧ Discharge overcurrent 1 protection voltage (V_{DOC1}): 3mV~100mV(Step:0.5mV),accuracy: ±1mV
  - ✧ Discharge overcurrent 2 protection voltage (V_{DOC2}): 10mV~200mV(Step:1mV),accuracy: ±2mV
  - ✧ Discharge short-circuit protection voltage (V_{SC}) : 20mV~400mV(Step:2mV),accuracy: ±5mV
  - ✧ Charge overcurrent protection voltage (V_{COC}): -60mV~-3mV(Step:0.5mV),accuracy: ±1mV
- **Internal Delay Time:**
  - ✧ Overcharge protection delay time (t_{OV}): 256ms/512ms/1s/2s
  - ✧ Overdischarge protection delay time (t_{UV}): 32ms/64ms/128ms/256ms
  - ✧ Discharge overcurrent protection delay time1 (t_{DOC1}): 8ms/16ms/32ms/64ms/128ms/256ms/1s/2s
  - ✧ Discharge overcurrent protection delay time2 (t_{DOC2}): 8ms/16ms/32ms/64ms
  - ✧ Discharge short-circuit protection delay time (t_{SC}): 280us/560us
  - ✧ Charge overcurrent protection delay time (t_{COC}): 8ms/16ms/32ms/64ms
- **Temperature Protection:**
  - ✧ T_{OTC}: 40℃,45℃,50℃,55℃
  - ✧ T_{OTD}: 55℃,60℃,65℃,70℃,75℃,80℃
  - ✧ T_{UTC}: -5℃,0℃,5℃,10℃
  - ✧ T_{UTD}: -20℃,-15℃,-10℃,-5℃
- **Current Consumption**
  - **Operation status: 2μA@25℃**
  - **Power-down status: 50nA@25℃**
- **Charge and Discharge Status Detection Function: Available, Unavailable**
- **CTL Pin Controls Charging and discharging FETs**
- **0V battery charge inhibited**
- **Operation Temperature: -40℃~85℃**
- **Package: DFN8(1515)**

note1:The magnitude of the overcharge hysteresis voltage is equal to a selected value between 0.05V and 0.4V with intervals of 50mV; (Overcharge hysteresis voltage=Overcharge protection threshold voltage - Overcharge protection release voltage)

note2:The magnitude of the over discharge hysteresis voltage is equal to a selected value between 0.1V and 0.7V with intervals of 100mV; (Over discharge hysteresis voltage=Over discharge protection release voltage - Over discharge protection threshold voltage)

2 Applications

- **IOT device**
- **Wearable device**
- **Battery pack**
- **Mobile device**

3 Description

IP3108 provides a solution for primary protection of single cell lithium-ion/polymer rechargeable batteries. IP3108 integrates all the necessary detection and protection for the safe operation of polymer rechargeable batteries. IP3108 integrates all protection detection and control functions, and only requires a working current of about 2μA for normal operation. The protection functions include detection and protection of discharge overcurrent, charging overcurrent, overcharging, and overdischarging batteries, detection and protection of external NTC resistors for over temperature and under temperature, and CTL pull-up to forcibly turn off CO and DO. It operates within a temperature range of -40 ℃ to + 85 ℃, greatly expanding the usage conditions of the chip. Adopting a small and thin DFN8 1.5mmx1.5mm package, this package facilitates the design of small battery application.

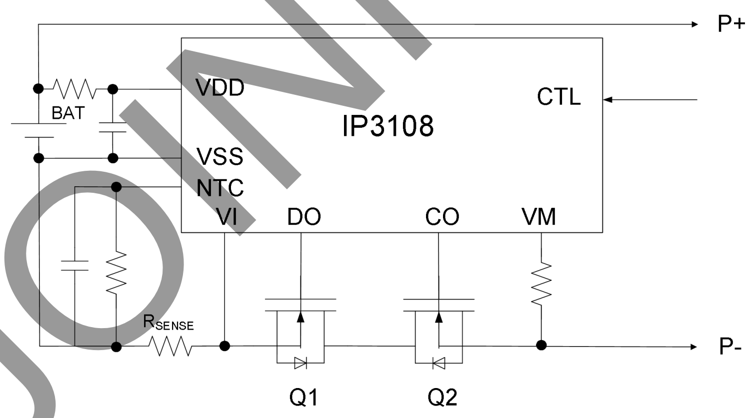

Fig1 Simplified Application Circuit

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4 Reversion History

Note: The page numbers of previous versions may differ from those of the current version.

Initial version V1.0 (November 2024)	**page number**
● Initial release	1~24

5 Pin Configuration

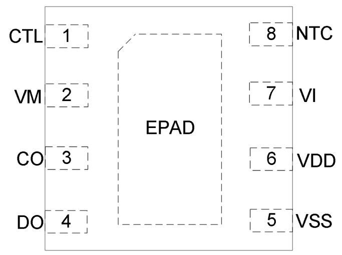


Fig2 DFN8 1.5X1.5mmPin diagram (top view)

Pin	Name	Description
1	CTL	Pull up the control to close the charging and discharging tube terminals, and the internal default is to pull down. If not in use, it can float
2	VM	Load and charger detection pins
3	CO	Charge control FET driver
4	DO	Discharge control FET driver
5	VSS	Negative power supply,logic ground
6	VDD	Positive power supply,connect 1uF capacitor to VSS
7	VI	Current detection Pin
8	NTC	Over temperature/under temperature detection thermistor connection pin, 10nF capacitor connected in parallel to VSS
EPAD	EPAD	Floating

6 Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
VDD pin input voltage range	VDD to VSS	-0.3 ~ 12	V
VM to VDD voltage range	VM to VDD	-28 ~ 0.3	V
CO to VDD voltage range	CO to VDD	-28 ~ 0.3	V
DO to VSS voltage range	DO to VSS	-0.3 ~ 12	V
VI/CTL/NTC pin voltage range	VI,CTL,NTC to VSS	-0.3 ~ VDD+0.3	V
Storage Temperature Range	T_{STG}	-55 ~ 125	℃
Thermal Resistance (Junction to Ambient)	θ_{JA}	120	℃/W
ESD (Human Body Model)	ESD	4	kV

*Stresses beyond these listed parameter may cause permanent damage to the device.
Exposure to Absolute Maximum Rated conditions for extended periods may affect device reliability.

7 Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input Voltage	VDD	2	--	6	V
Operating Temperature	T_A	-40	--	85	℃

*Device performance cannot be guaranteed when working beyond these Recommended Operating Conditions.

8 Product Name Structure and Product List

IP3108 XX

Product Name Code
（from AA to ZZ）

Table 1 Model List

Product List 1(1/2)

Product Name	$[V_{OV}]$	$[V_{OVR}]$	$[V_{UV}]$	$[V_{UVR}]$	$[V_{DOC1}]$	$[V_{DOC2}]$	$[V_{SC}]$	$[V_{COC}]$
IP3108AA	4.250V	4.100V	2.500V	3.000V	15.0mV	30mV	60mV	-15.0mV
IP3108AB	3.650V	3.450V	2.000V	2.500V	15.0mV	30mV	60mV	-15.0mV
IP3108AC	4.225V	4.025V	2.800V	3.000V	15.0mV	30mV	60mV	-15.0mV
IP3108AD	4.425V	4.275V	2.800V	3.000V	9.0mV	18mV	36mV	-9.0mV
IP3108AE	4.250V	4.200V	2.900V	3.000V	14.0mV	18mV	30mV	-12.0mV
IP3108AF	3.900V	3.800V	2.000V	2.300V	50.0mV	100mV	300mV	-50.0mV
IP3108AG	4.250V	4.150V	2.800V	3.000V	22.0mV	36mV	54mV	-22.0mV
IP3108AH	3.650V	3.450V	2.200V	2.500V	100.0mV	200mV	400mV	-60.0mV
IP3108AJ	3.900V	3.800V	2.000V	2.300V	100.0mV	200mV	400mV	-60.0mV
IP3108AK	3.900V	3.800V	2.000V	2.300V	100.0mV	200mV	400mV	-60.0mV
IP3108AL	4.225V	4.025V	2.800V	3.000V	15.0mV	30mV	60mV	-15.0mV

Product List 2(2/2)

Product Name	$[t_{OV}]$	$[t_{UV}]$	$[t_{DOC1}]$	$[t_{DOC2}]$	$[t_{SC}]$	$[t_{COC}]$	PD Enable	Temperature protection threshold combination*1
IP3108AA	1s	128ms	64ms	8ms	256μs	64ms	Yes	(1)
IP3108AB	1s	128ms	64ms	8ms	256μs	64ms	Yes	(1)
IP3108AC	1s	128ms	64ms	8ms	256μs	64ms	Yes	(1)
IP3108AD	1s	128ms	64ms	8ms	256μs	64ms	Yes	(1)
IP3108AE	1s	256ms	1s	8ms	256μs	32ms	Yes	(2)
IP3108AF	1s	256ms	128ms	8ms	256μs	64ms	No	(3)
IP3108AG	1s	256ms	1s	8ms	256μs	32ms	Yes	(4)
IP3108AH	1s	128ms	64ms	32ms	256μs	64ms	Yes	(5)
IP3108AJ	1s	128ms	64ms	32ms	256μs	64ms	Yes	(5)
IP3108AK	1s	128ms	64ms	32ms	256μs	64ms	Yes	(6)
IP3108AL	1s	128ms	64ms	8ms	256μs	64ms	Yes	(7)

*1: Refer to Table 2 for details on temperature thresholds.

Table 2 Temperature Threshold Combination Table

Temperature protection threshold	T_{OTC} /℃	T_{OTCR} /℃	T_{UTC} /℃	T_{UTCR} /℃	T_{OTD} /℃	T_{OTDR} /℃	T_{UTD} /℃	T_{UTDR} /℃	under temperature protection for discharge
(1)	50	45	-5	0	65	60	-	-	No
(2)	45	40	0	5	65	60	-20	-15	Yes
(3)	55	45	-5	0	65	55	-5	0	Yes
(4)	50	45	0	5	65	60	-20	-15	Yes
(5)	55	50	0	5	75	70	-20	-15	Yes
(6)	55	50	0	5	80	70	-20	-15	Yes
(7)	45	40	5	10	65	60	-15	-10	Yes

Note: If you need products other than the above specifications, please contact our business department.

9 Electrical Characteristics

Unless otherwise specified,VDD = 3.6V, typical value @T_A=25℃

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
power consumption						
Quiescent current(VDD current)	I_{OPE}	No load,VDD=3.6V,VM=0V	-	2	4	μA
Shut-down current(VDD current)	I_{PDN}	Power down mode,VDD=VM=1.8V	-	0.05	0.3	μA
protection voltage						
Overcharge protection voltage	V_{OV}	T_A=25℃	V_{OV}-0.015	V_{OV}	V_{OV}+0.015	V
		T_A=−20℃ ~ +60℃	V_{OV}-0.020		V_{OV}+0.020	
		T_A=−40℃ ~ +85℃	V_{OV}-0.030		V_{OV}+0.030	
Overcharge release voltage	V_{OVR}	V_{OV}≠V_{OVR}, T_A=25℃	V_{OVR}-0.030	V_{OVR}	V_{OVR}+0.030	V
		V_{OV}≠V_{OVR}, T_A=−20℃ ~ +60℃	V_{OVR}-0.040		V_{OVR}+0.040	
		V_{OV}≠V_{OVR}, T_A=−40℃ ~ +85℃	V_{OVR}-0.050		V_{OVR}+0.050	
		V_{OV}=V_{OVR}, T_A=25℃	V_{OVR}-0.015	V_{OVR}	V_{OVR}+0.015	
		V_{OV}=V_{OVR}, T_A=−20℃ ~ +60℃	V_{OVR}-0.020		V_{OVR}+0.020	
		V_{OV}=V_{OVR}, T_A=−40℃ ~ +85℃	V_{OVR}-0.030		V_{OVR}+0.030	
Overdischarge protection voltage	V_{UV}	T_A=25℃	V_{UV}-0.030	V_{UV}	V_{UV}+0.030	V
		T_A=−20℃ ~ +60℃	V_{UV}-0.040		V_{UV}+0.040	
		T_A=−40℃ ~ +85℃	V_{UV}-0.050		V_{UV}+0.050	
Overdischarge release voltage	V_{UVR}	V_{UV}≠V_{UVR}, T_A=25℃	V_{UVR}-0.050	V_{UVR}	V_{UVR}+0.050	V
		V_{UV}≠V_{UVR}, T_A=−20℃ ~ +60℃	V_{UVR}-0.060		V_{UVR}+0.060	
		V_{UV}≠V_{UVR}, T_A=−40℃ ~ +85℃	V_{UVR}-0.070		V_{UVR}+0.070	
		V_{UV}=V_{UVR}, T_A=25℃	V_{UVR}-0.030	V_{UVR}	V_{UVR}+0.030	
		V_{UV}=V_{UVR}, T_A=−20℃ ~ +60℃	V_{UVR}-0.040		V_{UVR}+0.040	
		V_{UV}=V_{UVR}, T_A=−40℃~ +85℃	V_{UVR}-0.050		V_{UVR}+0.050	
Discharge overcurrent 1 protection voltage	V_{DOC1}	T_A=25℃	V_{DOC1}-1.0	V_{DOC1}	V_{DOC1}+1.0	mV
		T_A=−20℃ ~ +60℃	V_{DOC1}-1.5		V_{DOC1}+1.5	
		T_A=−40℃ ~ +85℃	V_{DOC1}-1.5		V_{DOC1}+1.5	
Discharge overcurrent 2 protection voltage	V_{DOC2}	T_A=25℃	V_{DOC2}-2	V_{DOC2}	V_{DOC2}+2	mV
		T_A=−20℃ ~ +60℃	V_{DOC2}-3		V_{DOC2}+3	
		T_A=−40℃ ~ +85℃	V_{DOC2}-3		V_{DOC2}+3	
Discharge overcurrent protection release voltage	V_{DOCR}	VDD=3.6V	0.77×VDD	0.8×VDD	0.83×VDD	V
Charge overcurrent protection voltage	V_{COC}	T_A=25℃	V_{COC}-1	V_{COC}	V_{COC}+1	mV
		T_A=−20℃ ~ +60℃	V_{COC}-1.5		V_{COC}+1.5	
		T_A=−40℃ ~ +85℃	V_{COC}-1.5		V_{COC}+1.5	

Discharge short-circuit protection voltage	V_{SC}	T_A=−40℃ ~ +85℃ VI voltage	V_{SC}-5	V_{SC}	V_{SC}+5	mV
protection delay						
Overcharge protection delay time	t_{OV}	T_A=25℃	t_{OV}×0.8	t_{OV}	t_{OV}×1.2	ms
Overdischarge protection delay time	t_{UV}	T_A=25℃	t_{UV}×0.8	t_{UV}	t_{UV}×1.2	ms
Discharge overcurrent 1 protection delay time accuracy	t_{DOC1}	T_A=25℃	t_{DOC1}×0.8	t_{DOC1}	t_{DOC1}×1.2	ms
Discharge overcurrent 2 protection delay time accuracy	t_{DOC2}	T_A=25℃	t_{DOC2}×0.8	t_{DOC2}	t_{DOC2}×1.2	ms
Discharge short-circuit protection delay time accuracy	t_{SC}	T_A=25℃	t_{SC}×0.7	t_{SC}	t_{SC}×1.3	μs
Charge overcurrent protection delay time accuracy	t_{COC}	T_A=25℃	t_{COC}×0.8	t_{COC}	t_{COC}×1.2	ms
CTL control charge-discharge inhibition delay time accuracy	t_{CTL}	T_A=25℃	51.2	64	76.8	ms
OTD,OTC,UTD,UTC Delay	t_{NTC_FAULT}	-	1.5	3	5	s
0V charging						
0V prohibits charging battery voltage threshold	V_{0INH}	When charging is prohibited for 0V batteries	0.7	1.2	1.7	V
CTL voltage						
CTL pin voltage "H"	V_{CTLH}	-	1.2	-	-	V
CTL pin voltage "L"	V_{CTLL}	-	-	-	0.4	V
Driving voltage						
DO voltage	V_{DO}	Normal state, DO high level	VDD-0.15	-	VDD	V
CO voltage	V_{CO}	Normal state, CO high level	VDD-0.15	-	VDD	V
Output resistance						

DO pin resistance'H'	R_{DOH}		5	10	20	kΩ
DO pin resistance'L'	R_{DOL}		1	2	4	kΩ
CO pin resistance'H'	R_{COH}		2.5	4.5	6.5	kΩ
CO pin resistance'L'	R_{COL}		2.5	4.5	6.5	kΩ
Internal resistance						
VM pull-up resistance	R_{VMD}		150	300	600	kΩ
VM pull-down resistance	R_{VMS}		10	20	30	kΩ
protection temperature						
Charging-status over temperature protection temperature	T_{OTC}	NTC: 103AT	T_{OTC}-3	T_{OTC}	T_{OTC}+3	℃
	T_{OTCR}	NTC: 103AT	T_{OTCR}-3	T_{OTCR}	T_{OTCR}+3	℃
Discharge-status over temperature protection	T_{OTD}	NTC: 103AT	T_{OTD}-3	T_{OTD}	T_{OTD}+3	℃
	T_{OTDR}	NTC: 103AT	T_{OTDR}-3	T_{OTDR}	T_{OTDR}+3	℃
Charge-status under temperature protection	T_{UTC}	NTC: 103AT	T_{UTC}-3	T_{UTC}	T_{UTC}+3	℃
	T_{UTCR}	NTC: 103AT	T_{UTCR}-3	T_{UTCR}	T_{UTCR}+3	℃
Discharge-status under temperature protection	T_{UTD}	NTC: 103AT	T_{UTD}-3	T_{UTD}	T_{UTD}+3	℃
	T_{UTDR}	NTC: 103AT	T_{UTDR}-3	T_{UTDR}	T_{UTDR}+3	℃

Note: The resistance of DO and CO terminals and the parameters of charge and discharge MOSFETs are related to the switching time. It is recommended to select MOSFETs based on the terminal resistance.

10 Functional Description

10.1 System Diagram

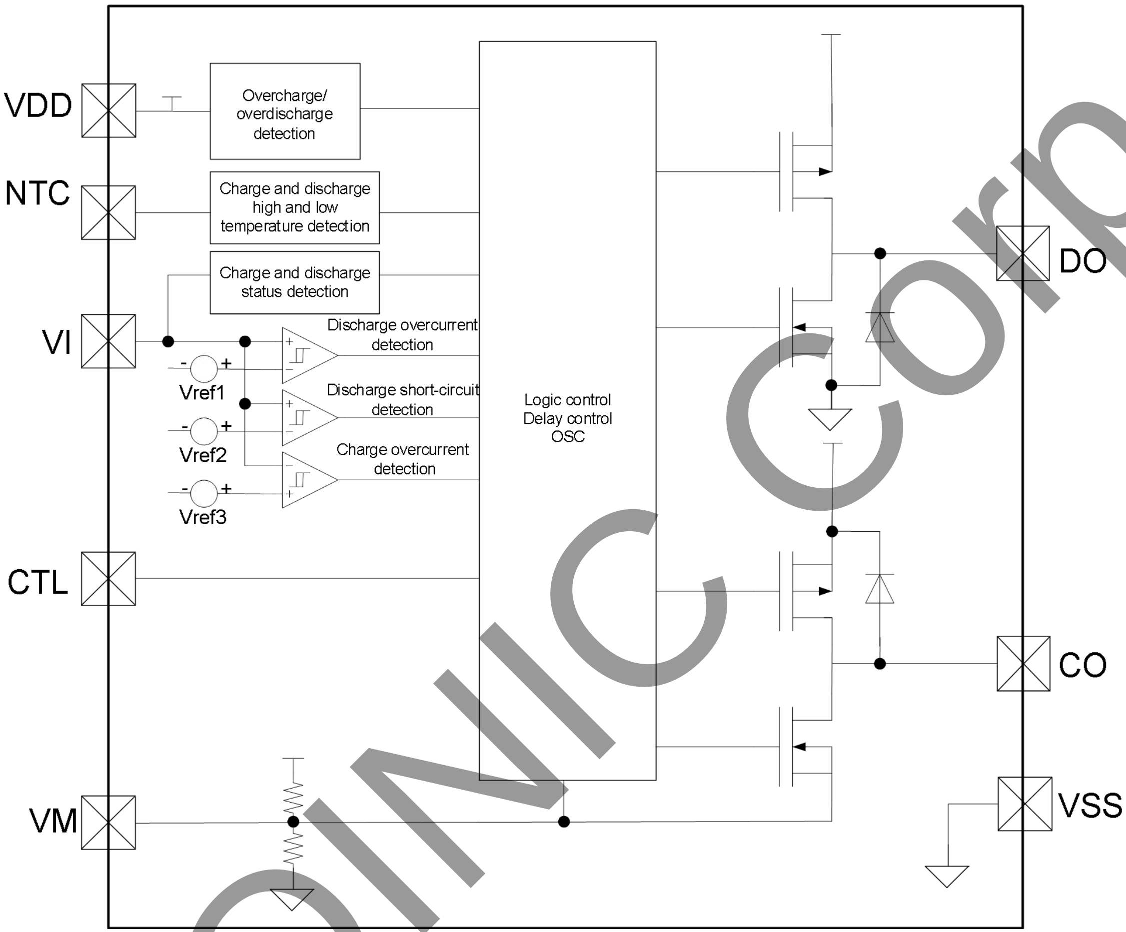


Fig3 Internal System Diagram

10.2 Overview

IP3108 provides a solution for primary protection of lithium-ion/polymer rechargeable batteries. This product integrates all the necessary detection and protection for the safe operation of polymer rechargeable batteries. IP3108 only requires a working current of about 2μA. The protection functions include detection and protection against overcharging, overdischarging,charging overcurrent, discharging overcurrent, charging and discharging overheating, and under temperature. It operates within a temperature range of -40℃ to +85 ℃, greatly expanding the usage conditions of the chip. IP3108 controls charging and discharging by monitoring the battery voltage between the VDD terminal and the VSS terminal, as well as the VI/VM terminal voltage.

10.3 Overcharge Status

V_{OVR}≠ V_{OV}(overcharge release voltage differs from overcharge protection voltage):

When the battery voltage becomes higher than V_{OV} during charging in the normal status and the condition continues for the overcharge protection delay time(t_{OV})or longer, IP3108 turns the charge control FET off to stop charging. This status is called the overcharge status. The overcharge status is released in the following two cases:

(1)In the case that the VM pin voltage is lower than 0.25V(typ.), IP3108 releases the overcharge status when the battery voltage falls below overcharge release voltage (V_{OVR}).

(2)In the case that the VM pin voltage is equal to or higher than 0.25V(typ.), IP3108 releases the overcharge status when the battery voltage falls below V_{OV}.

When the discharge is started by connecting a load after the overcharge protection, the VM pin voltage rises by the V_f voltage of the internal parasitic diode than the VSS pin voltage, because the discharge current flows through the parasitic diode in the charge control FET(Q2). If this VM pin voltage is equal to or higher than 0.25 V (typ.), IP3108 releases the overcharge status when the battery voltage is equal to or lower than V_{OV}.

V_{OVR}= V_{OV} (overcharge release voltage is the same as overcharge detection voltage):

When the battery voltage becomes higher than V_{OV} during charging in the normal status and the condition continues for t_{OV} or longer, IP3108 turns the charge control FET(Q2) off to stop charging. This status is called the overcharge status. In the case that the VM pin voltage is equal to or higher than 0.25 V(typ.). and the battery voltage falls below V_{OV}, IP3108 releases the overcharge status.

During charging, if the battery voltage in the normal state exceeds VOV and this state remains above the overcharge detection delay (t_{OV}), the charging control switch (Q2) will be turned off to stop charging. This state is called an overcharge state. When the battery voltage drops below VOV, the overcharge state can be released.

Note that for batteries discharged beyond V_{OV}, even if a larger load is connected, the battery voltage cannot drop below V_{OV}. Before the battery voltage drops to V_{OV}, discharge overcurrent and load short circuit detection cannot be effective, and the chip will not trigger discharge overcurrent and load short circuit states by mistake. However, in reality, the internal impedance of the battery is several tens of milliohms. When a large load that can cause overcurrent is connected, the battery voltage will immediately decrease. Therefore, discharge overcurrent and load short circuit detection can be effective.

Note: When a discharge state is detected, even if the battery voltage is still higher than VOV, the CO terminal outputs a high level and the charging control switch (Q2) is turned on.

10.4 Overdischarge Status

When the battery voltage falls below V_{UV} during discharging in the normal status and the condition continues for the overdischarge protection delay time (t_{UV}) or longer, IP3108 turns the discharge control FET(Q1) off to stop discharging. This status is called the overdischarge status. Under the overdischarge status, The VM pin voltage is pulled up. When connecting a charger in the overdischarge status, the battery voltage reaches V_{UV} or higher and IP3108 releases the overdischarge status if the VM pin voltage is below 0 V(typ.).

The battery voltage reaches the overdischarge release voltage (V_{UV}) or higher and IP3108 releases the overdischarge status if the VM pin voltage is not below 0 V(typ.).If the charging status detection option is enabled, in the over discharge state, if the charging status is detected, the discharge control switch DO tube will be forcibly turned on to prevent the discharge tube from being damaged by the charging current passing through the discharge tube diode for a long time.

With power-down function:

In the over discharge state, if the voltage between the VM terminals rises above VDDx0.7 (typical value), the sleep function will start working, and the current consumption will be reduced to 50nA during sleep. By connecting the charger, the voltage from the VM terminal to the VSS terminal can be reduced to VDDx0.3 (typical value) or below to release the sleep function.

• When a battery is not connected to a charger and the VM pin voltage ≥ 0.3 x VDD(typ.), IP3108 maintains the overdischarge status even when the battery voltage reaches V_{UVR} or higher.

• When a battery is connected to a charger and 0.3 x VDD(typ.) > the VM pin voltage > 0 V(typ.), the battery voltage reaches V_{UVR} or higher and IP3108 releases the overdischarge status.

• When a battery is connected to a charger and 0 V(typ.)≥the VM pin voltage, the battery voltage reaches V_{UV} or higher and IP3108 releases the overdischarge status.

Note: Chips with sleep function may not discharge when connected to the battery for the first time. In this case, if a charger is connected, it will switch to the normal state

Without power-down function:

In the over discharge state, even if the voltage between the VM terminals rises above VDDx0.7 (typ.), the sleep function does not work.

• When connecting the charger and the VM terminal voltage is greater than 0V (typ.), if the battery voltage is above V_{UVR}, release the over discharge state.

• When the charger is connected and 0V (typical value) is greater than or equal to the VM terminal voltage, and the battery voltage is above V_{UV}, the over discharge state is released;

Note: When the charging status is detected, even if the battery voltage is still below VUV, the DO terminal outputs a high level and the discharge control switch (Q1) is turned on.

10.5 Discharge Overcurrent Status

In the normal state of the battery, the current detection terminal VI voltage will increase with the increase of discharge current. When the VI terminal voltage rises above the discharge overcurrent 1 protection voltage (V_{DOC1}) and continues to exceed the discharge overcurrent 1 protection delay (t_{DOC1}), it will enter the discharge overcurrent 1 state; When the voltage at the VI terminal rises above the discharge overcurrent 2 protection voltage (V_{DOC2}) and continues to exceed the discharge overcurrent 2 protection delay (t_{DOC2}), it will enter the discharge overcurrent 2 state; After either of the above two states occurs, the discharge control switch (Q1) will be turned off to stop the discharge.

In the discharge overcurrent state, a short circuit is caused between the internal VM terminal and the VSS terminal through a resistor. However, during the period when the load is connected, the VM terminal voltage changes to the VDD terminal voltage due to the connection of the load. If the connection with the load is disconnected, the VM terminal voltage will return to the VSS terminal voltage. When the voltage at the VM terminal drops below V_{DOCR}, the discharge overcurrent state can be released.

10.6 Load Short-circuit

When a battery in its normal state is connected to a load that can cause a short circuit, if the voltage at the VI terminal rises above VSC and the state continues to remain above the load short circuit protection delay (t_{SC}), the discharge control switch (Q1) will be turned off to stop discharging. This state is called a load short circuit state.

The method for relieving load short circuit state is the same as discharging overcurrent.

10.7 Charge Overcurrent Status

In the normal state of the battery, due to the charging current being above the set value, the voltage at the current detection terminal VI will drop below V_{COC}. If this state continues to remain above the charging overcurrent protection delay (t_{COC}), the charging control switch (Q2) will be turned off to stop charging. This state is called charging overcurrent state. When the VM terminal voltage rises above 0.25V (typical value) by disconnecting from the charger or adding an external load, the charging overcurrent state can be released. When the charging overcurrent state is released, the charging tube will conduct and the VM will be pulled to VSS without triggering the discharge overcurrent state. In the over discharge state, the charging overcurrent detection does not work.

10.8 0V Battery Charge Inhibited

When the battery voltage is below the 0V battery charging prohibition battery voltage threshold (V_{0INH}), the gate of the charging control switch (Q2) is fixed at the P-terminal voltage and charging is prohibited. When the battery voltage is above V_{0INH}, charging can be carried out.

10.9 CTL Control Logic

When the voltage at the CTL terminal of the control logic is above the CTL terminal voltage "H" (V_{CTLH}) and this state continues to remain above the charge discharge prohibition delay (t_{CTL}), the charging control switch (Q2) and the discharging control switch (Q1) will be closed to stop charging and discharging. This state is called a charge discharge prohibition state. On the contrary, when the CTL terminal voltage is below "L" (V_{CTLL}), open the charging control switch (Q2) and the discharging control switch (Q1) to charge and discharge. If CTL is floating, the internal default will be pulled down, and the charging and discharging status will be determined by the protection status.

10.10 Charging and Discharging Status Detection

IP3108 integrated charging and discharging state comparator, when the VI voltage is detected to be lower than the typical value of -7mV, it is in charging state, and the typical value for exiting charging state is -4mV; When the VI voltage is higher than the typical value of 8mV, it is in a discharge state, and the typical value for exiting the discharge state is 5mV; The charging state detection is turned on when the discharge protection occurs, and the discharging state detection is turned on when the charging protection occurs. It is used to quickly turn on the detection tube after the charging and discharging state changes to protect the charging and discharging MOSFET.

After charging over temperature, under temperature, and overcharge protection, the charging MOSFET will be turned off. If the discharge temperature range is met at this time, when discharging, if the discharge state detection VI voltage is higher than the discharge state threshold 8mV, the charging tube will quickly turn on after a delay of 0.5ms to protect the charging MOSFET.

After the discharge undervoltage protection, if the charging state detects that the VI voltage is lower than the charging state threshold of -7mV, the discharge tube will be quickly turned on after a delay of 0.5ms to protect the discharge MOSFET.

10.11 Temperature Protection

Charging over temperature state

During the charging process, if the temperature is detected to be higher than the charging over temperature protection temperature T_{OTC} and this state is maintained for a certain delay t_{NTC_AULT}, it will enter the charging over temperature state and turn off the charging switch (Q2).

If one of the following conditions is met, exit the charging over temperature state and turn on the charging switch (Q2):

1. If the temperature is detected to be lower than the charging over temperature release temperature TOTCR and the typical value is maintained for 3 seconds with a delay;

2. Exit charging, start discharging, and the discharge state detection determines it as a discharge state.

Under temperature charging state

During the charging process, if the temperature is detected to be lower than the charging under-temperature protection temperature T_{UTC} and this state is maintained for a certain delay t_{NTC_AULT}, the charging under-temperature state will be entered and the charging switch (Q2) will be turned off.

If one of the following conditions is met, exit the under-temperature charging state and turn on the charging switch (Q2):

1. If the temperature is detected to be higher than the charging under-temperature release temperature TUTCR and the typical value is maintained for 3 seconds with a delay;

2. Exit charging, start discharging, and the discharge state detection determines it as a discharge state.

Discharge over temperature state

During the discharge process, if the temperature is detected to be higher than the discharge over temperature protection temperature T_{OTD} and this state is maintained for a certain delay t_{NTC_FAULT}, the discharge over temperature state will be entered and the discharge switch (Q1) will be turned off.

If the following conditions are met, exit the discharge over temperature state and turn on the discharge switch (Q1):

If the temperature is detected to be lower than the discharge over temperature release temperature T_{OTDR} and the typical value is maintained for a delay of 3 seconds.

Under temperature discharge state

During the discharge process, if the temperature is detected to be lower than the discharge under-temperature protection temperature T_{UTD} and this state is maintained for a certain delay t_{NTC_AULT}, the discharge under-temperature state will be entered and the discharge switch (Q1) will be turned off.

If the following conditions are met, exit the discharge under-temperature state and turn on the discharge switch (Q1):If the temperature is detected to be higher than the discharge under-temperature release temperature T_{UTDR} and the typical value is maintained for a delay of 3 seconds.

Table 3 Temperature Threshold Options Table

Selection of discharge over temperature threshold	80℃	75℃	70℃	65℃	60℃	55℃
Selection of discharge over temperature release threshold	75℃	70℃	65℃	60℃	55℃	50℃
Selection of charging over temperature threshold	55℃	50℃	45℃	40℃		
Selection of charging over temperature release threshold	50℃	45℃	40℃	35℃		
Selection of under Temperature Threshold for Charging	10℃	5℃	0℃	-5℃		
Selection of charging under-temperature release threshold	15℃	10℃	5℃	0℃		
Selection of discharge under temperature threshold	-5℃	-10℃	-15℃	-20℃		
Selection of discharge under-temperature release threshold	0℃	-5℃	-10℃	-15℃		

11 Timing Charts

11.1 Overcharge detection, overdischarge detection

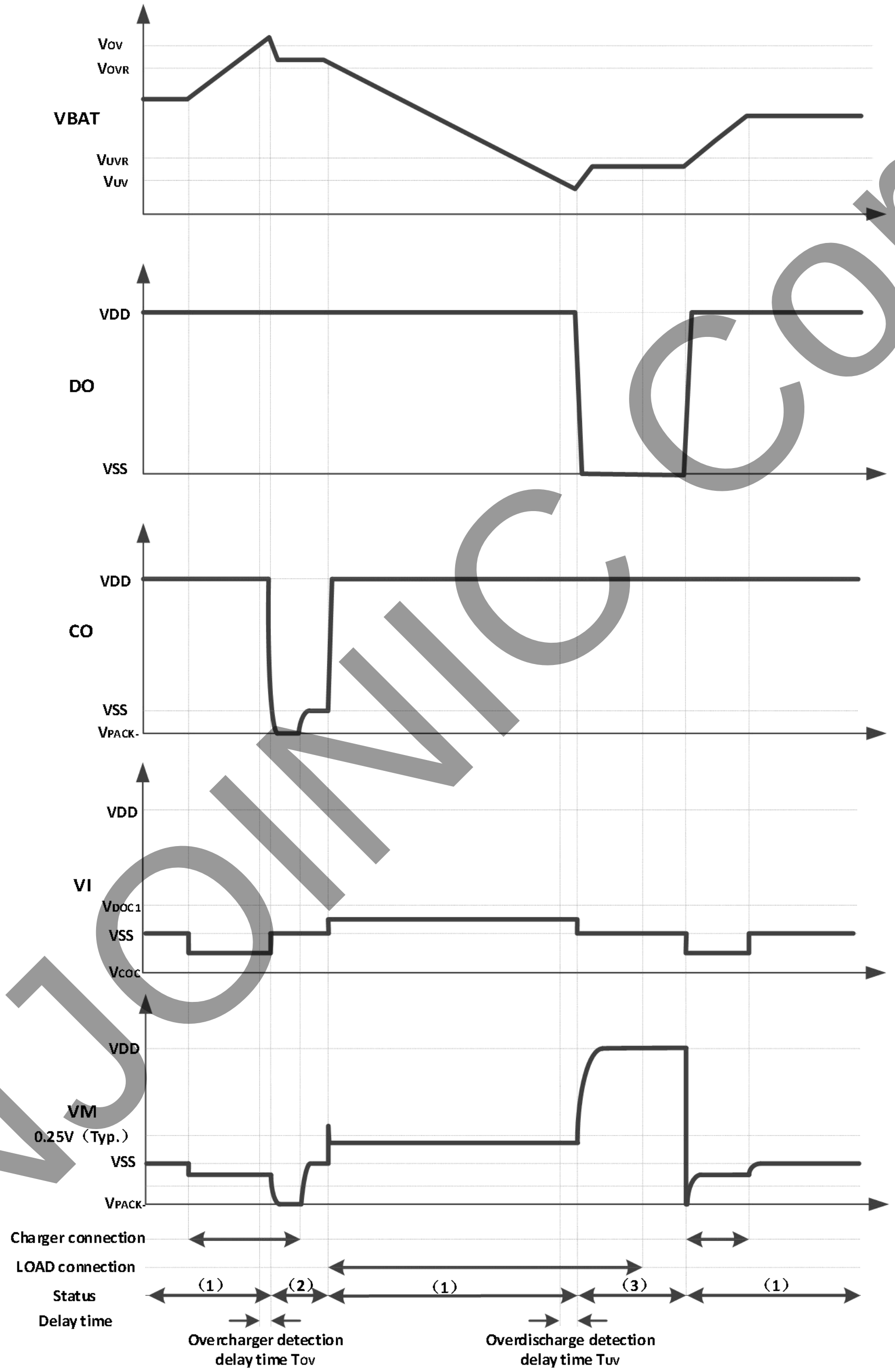


Fig4 Overcharge detection, overdischarge detection timing chart

Note: (1) Normal status

(2) Overcharge status

(3) Overdischarge status

11.2 Discharge overcurrent detection

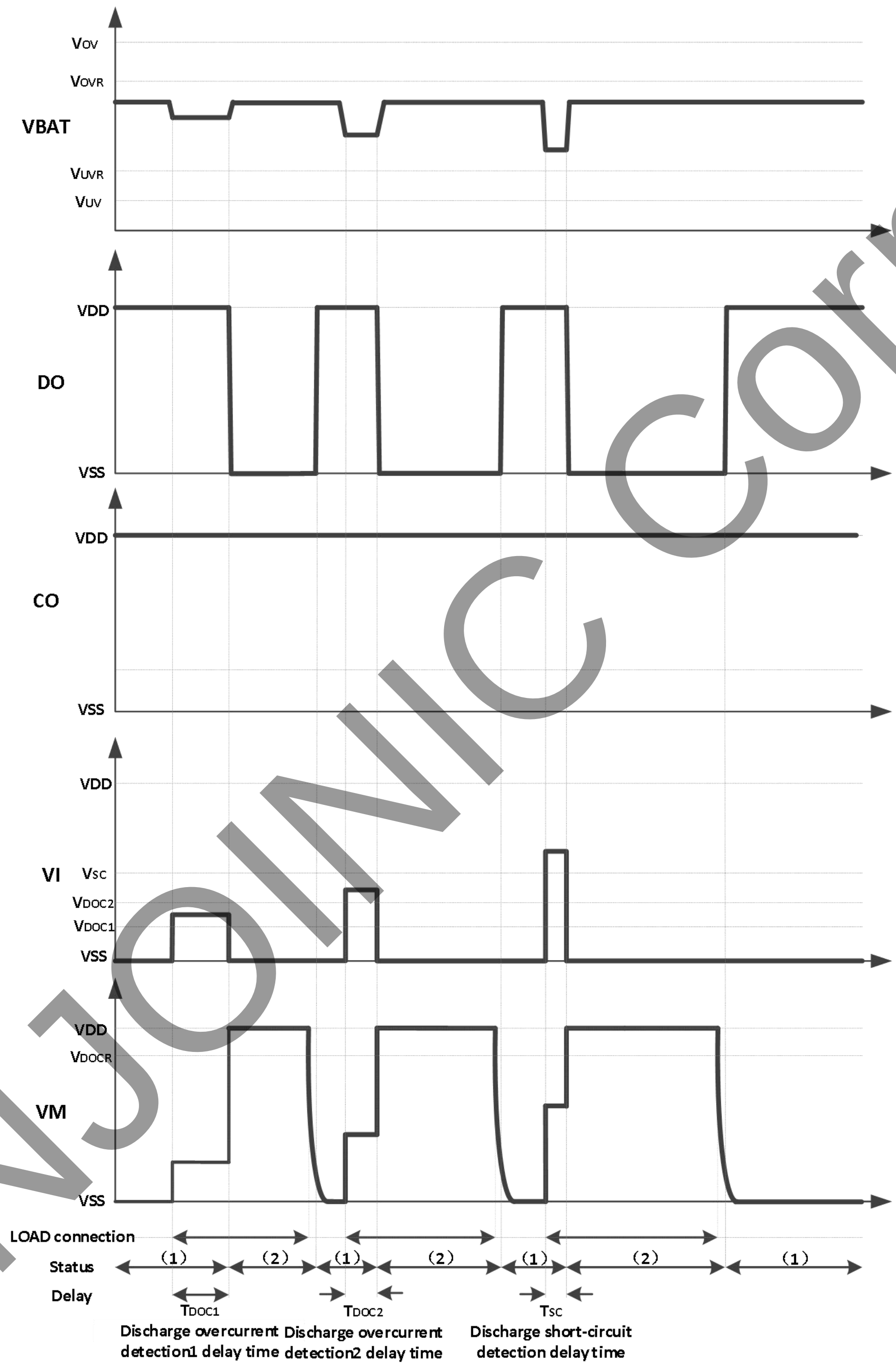


Fig5 Discharge overcurrent detection timing chart

Note: (1) Normal status

(2) Discharge overcurrent status

11.3 Discharge overcurrent release

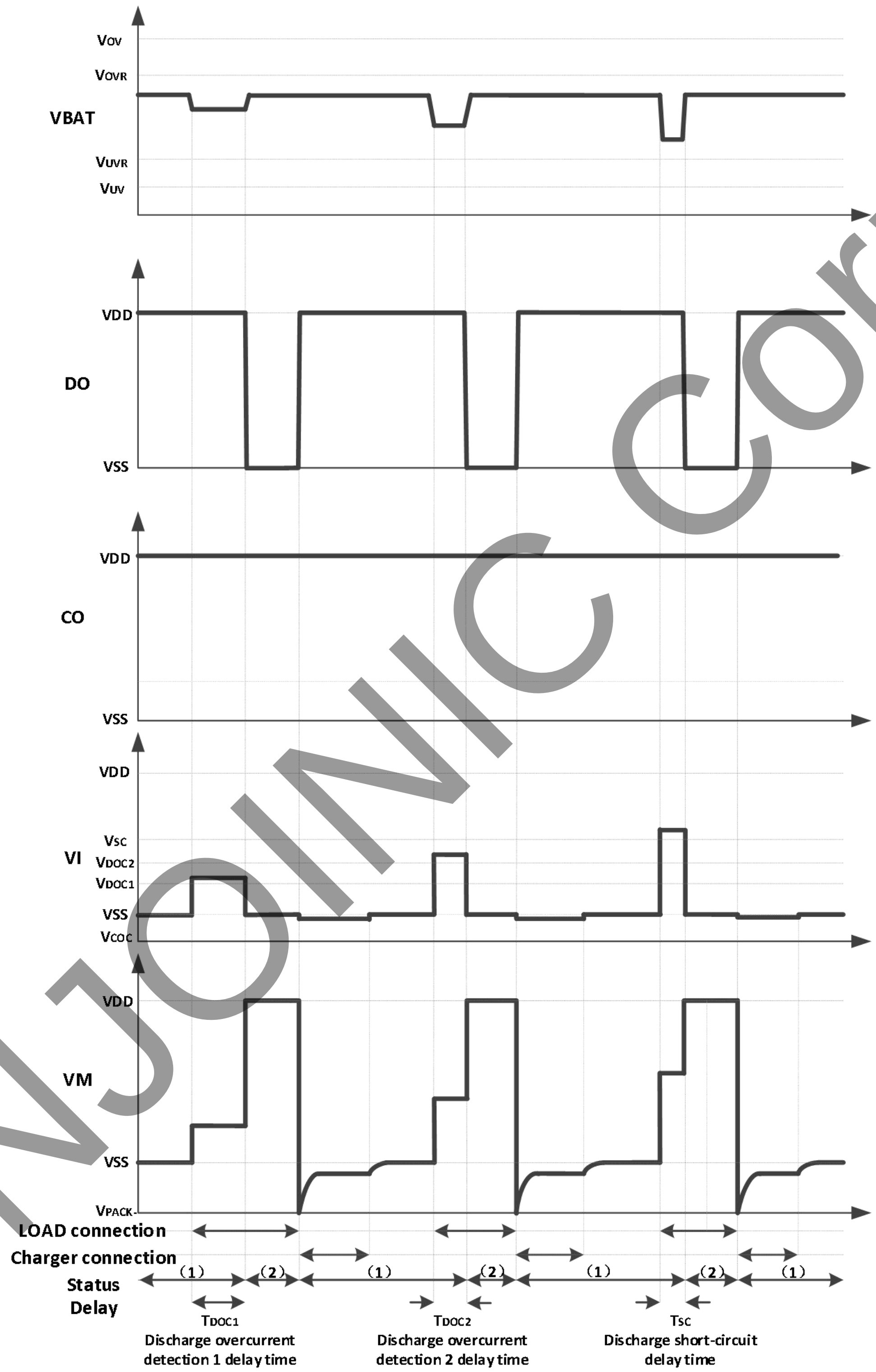


Fig6 discharge overcurrent release timing chart

Note: (1) Normal status

(2) Discharge overcurrent status

11.4 Charge overcurrent detection

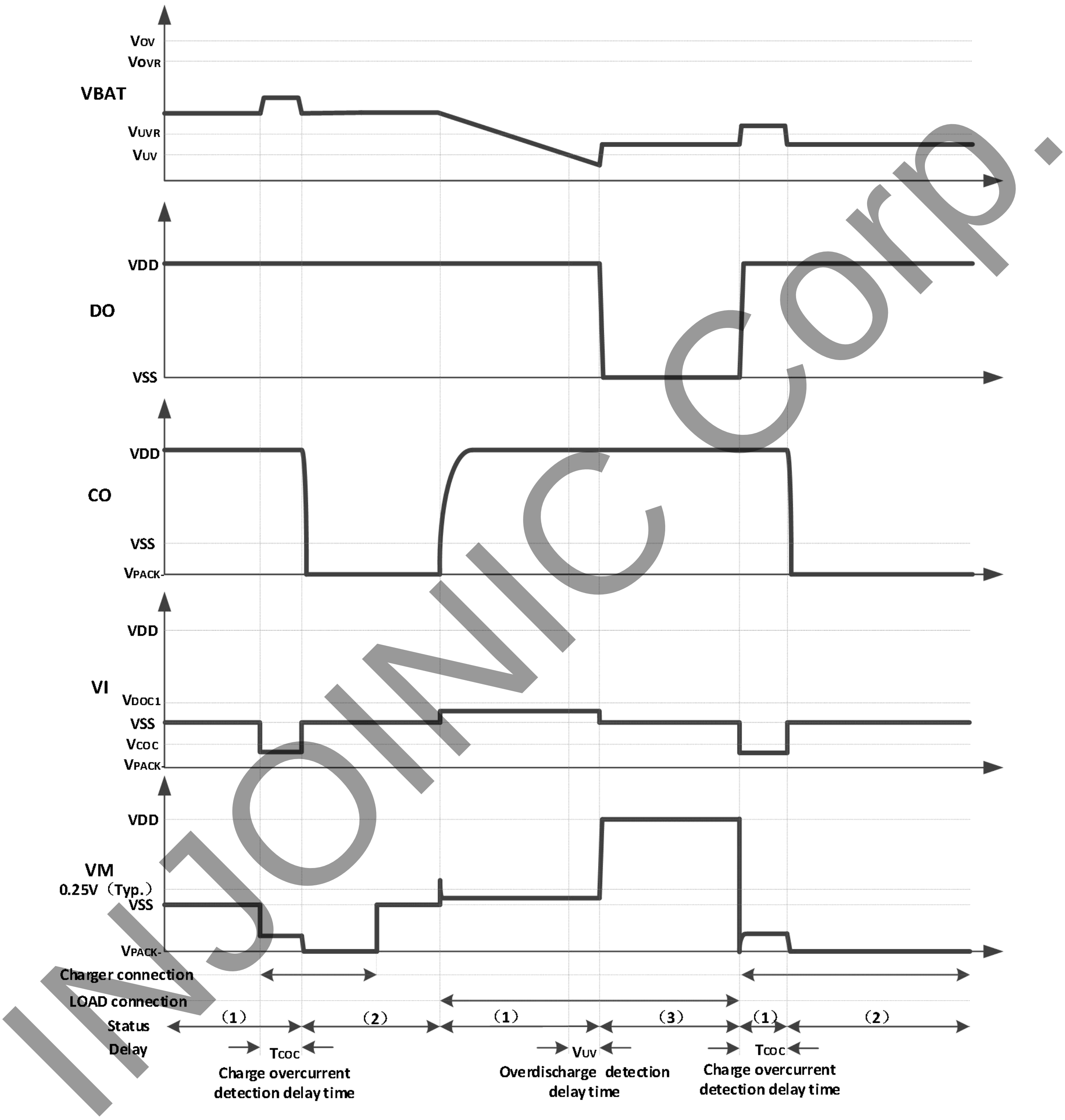


Fig7 charge overcurrent detection timing chart

Note: (1) Normal status

(2) Charge overcurrent status

(3) Overdischarge status

11.5 NTC detection

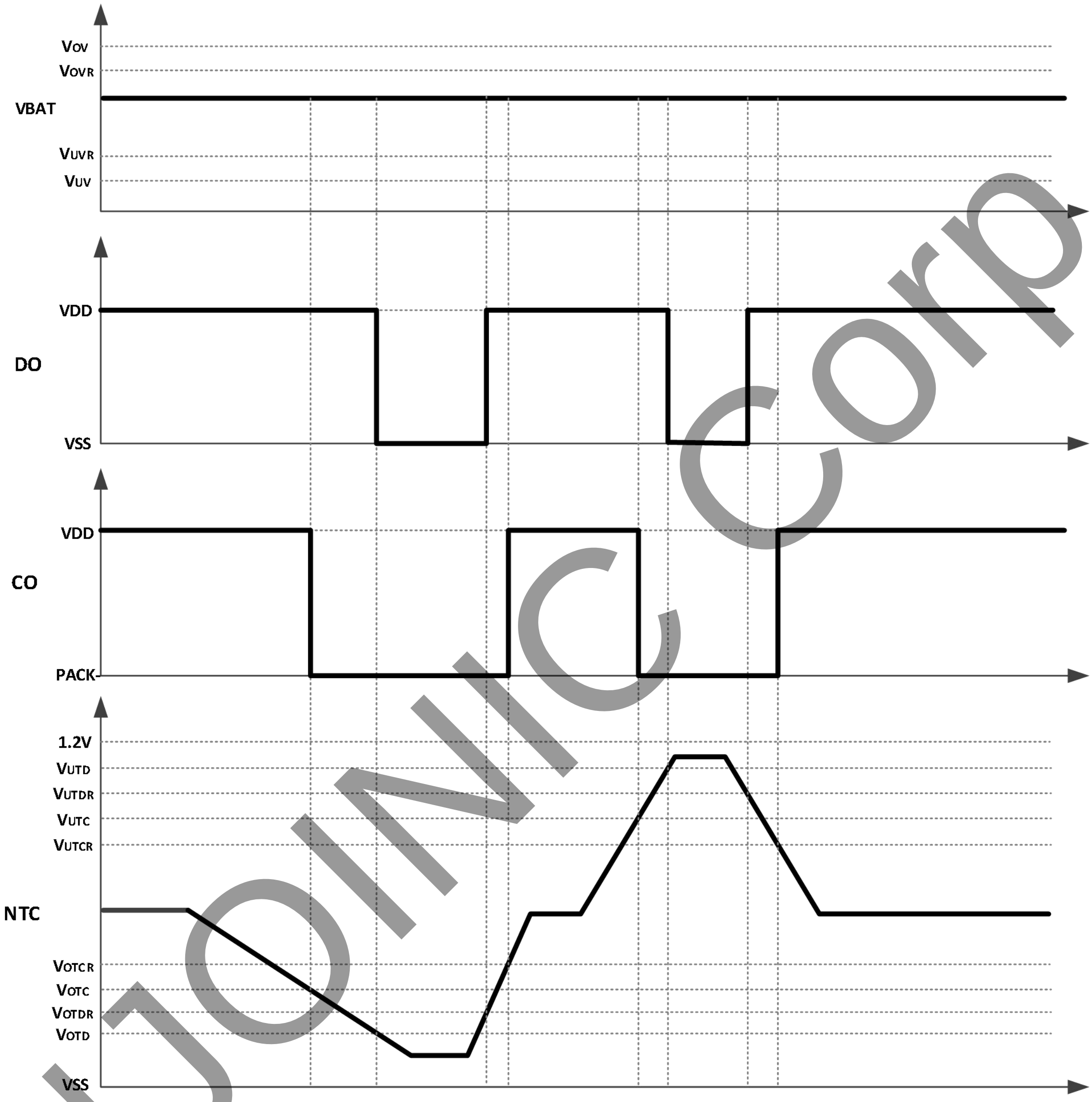


Fig 8 Timing diagram of NTC high and under temperature protection operation

12 Application Examples

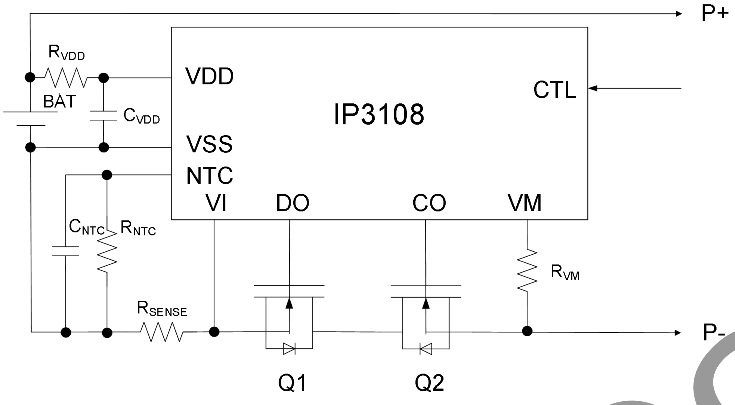


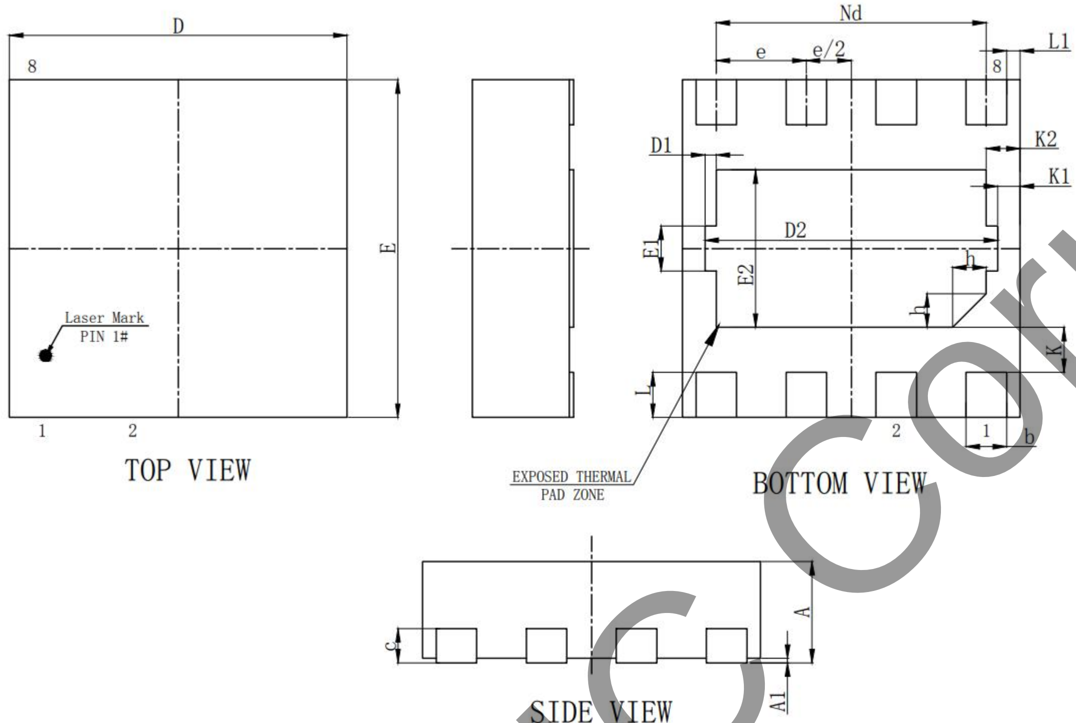
Fig9 Typical Application

Note:

Symbol	Device	Function	Typ.	Max
R_{VDD}	Resistor	Power RC filter and current-limiting	330Ω	470Ω
C_{VDD}	Capacitor	Power RC filter	1μF	
R_{SENSE}	Sensing resistor	High accuracy current sensing	2mΩ	
R_{VM}	Resistor	ESD and Reverse protection	330Ω	470Ω
R_{NTC}	NTC Resistor	Battery temperature detection	103AT,B=3435	
C_{NTC}	NTC Capacitor	Improve NTC accuracy	10nF	
Q1	N MOSFET	Discharge protection		
Q2	N MOSFET	Charging protection		

Note: The above parameters may be changed without prior notice.

13 Package Information



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.40	0.45	0.50
A1	0.00	0.02	0.05
b	0.13	0.18	0.23
c	0.152REF		
D	1.45	1.50	1.55
D1	0.05REF		
D2	1.20	1.30	1.40
e	0.40BSC		
Nd	1.20BSC		
E	1.45	1.50	1.55
E1	0.20REF		
E2	0.60	0.70	0.80
L	0.15	0.20	0.25
L1	0.06REF		
K	0.20REF		
K1	0.10REF		
K2	0.15REF		
h	0.10	0.15	0.20

Fig10 IP3108 DFN8 1.5x1.5mm

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