BM210 Series

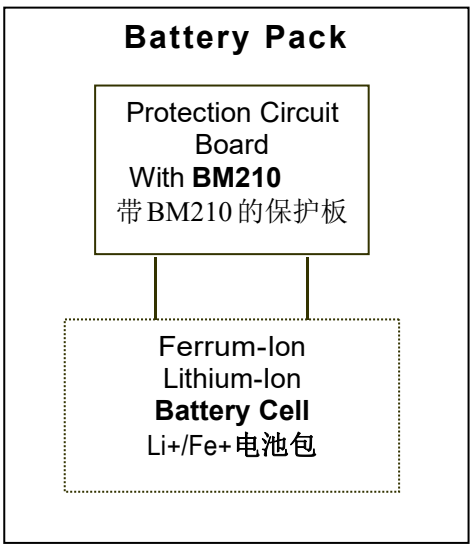
Two-cell Battery Protectors

General Description
概述

The BM210 series are protection ICs for Li+/Fe+ rechargeable battery packs. It includes voltage detection unit, voltage reference unit, bias unit, delay unit, and logic circuits. The BM210 series have high-accuracy voltage detection for protecting Two-cell ferrous battery packs from overcharge, overdischarge, overcurrent and short circuit.

BM210 系列是 Li+/Fe+可充电电池的保护芯片。芯片内置电压检测，电压基准，偏置，延时和逻辑单元。BM210 系列 IC 可为双节电池提供过充电，过放电，过电流和短路等保护。

Applications
应用



Features
特点

- **Overcharge Detection Voltage**
  过充电检测电压
  - 3.600~ 4.500V
  - Accuracy（精度）±25mV (25℃)
    ±50mV (-40℃~85℃)

- **Overdischarge Detection Voltage**
  过放电检测电压
  - Typ. 2.000V~3.000V
  - Accuracy（精度） ±80mV

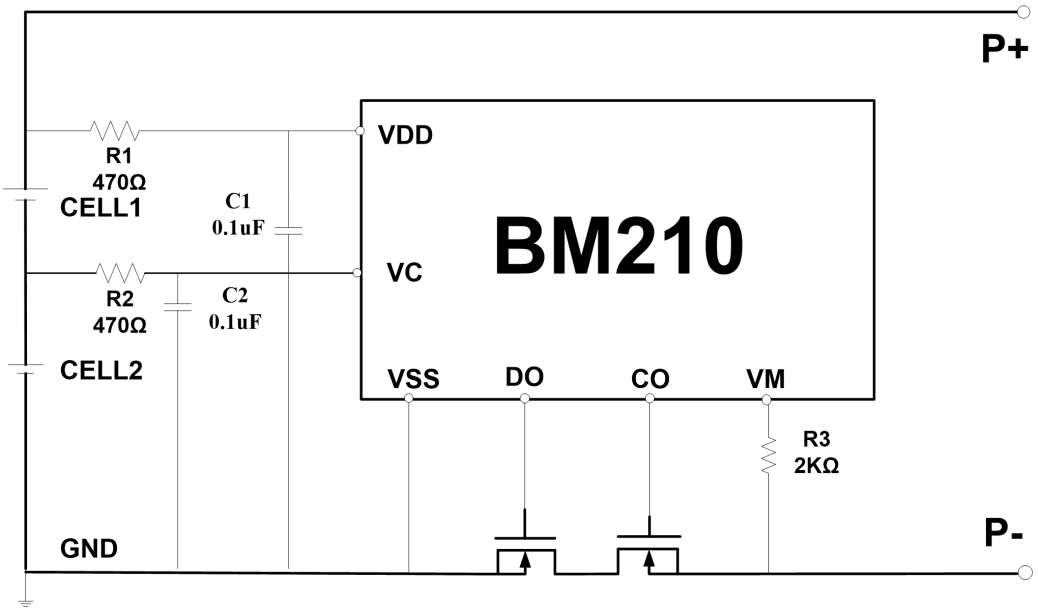
- **Discharge Overcurrnet Detection Voltage**
  放电过电流检测电压
  - Typ. 0.100V~0.300V @ VDD=VCC=3.300V
  - Accuracy （精度） ±0.030V

- **Short Circuit Detection Voltage**
  短路检测电压
  - Typ. 1.000V @ VDD=VCC=3.300V
  - Accuracy（精度） ±0.200V

- **Low power consumption**
  低功耗
  - Typ.5.0uA @ VC = 3.300V, VDD=6.600V (Standard working current)
  - Typ. 0.2uA @ VC =1.900V, VDD=3.800V (Without auto wake up)
  - Typ. 2.2uA @ VC =1.900V, VDD=3.800V (With auto wake up)

Typical Application Circuits

典型应用电路



Recommended value:

推荐参数值：

R1=470Ω；R2=470Ω；
R3=2kΩ；C1=C2=0.1uF 。

Notes

注释

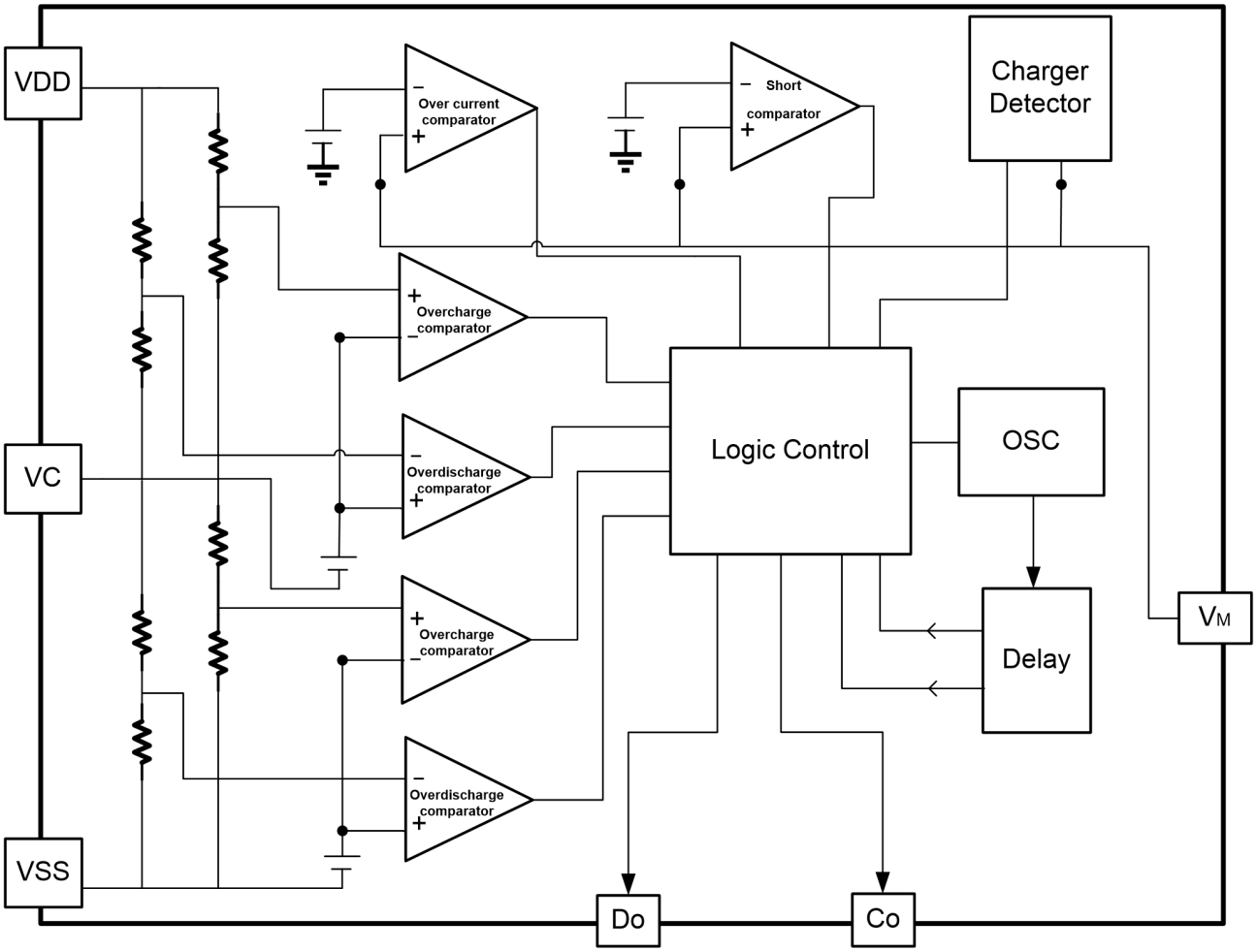
R1C1, R2C2 stabilize the supply voltage of the BM210 series. R1C1 is hence regarded as the time constant for VDD pin. R2C2 is hence regarded as the time constant for VC pin. R1 and R3 can also be a part of current-limit circuit for the BM210 series. Recommended values of these elements are as follows:

R1C1, R2C2 用来稳定 BM210 系列的供电电压。R1C1 也是 VDD 端子的时间常数，R2C2 是 VC 端子的时间常数，R1 和 R3 也是 BM210 系列限流电路的一部分。各电阻电容推荐值如下：

- 100Ω< R1,R2<1KΩ. A larger value of R1，R2 results in low detection accuracy.
  R1，R2 过大会导致检测精度降低。
- 1kΩ< R3<4kΩ. A larger value of R3 possibly counteracts resetting from Overdischarge even with a charger.
  R3 值过大会影响过放状态的连接充电器的重置。
- 0.05uF<C1,C2<1.0uF. C1，C2 is too small, it is possible to cause disoperation in the event of power fluctuation.
  C1，C2 电容值过小，在电源波动时可能引起误动作。

Block Diagram

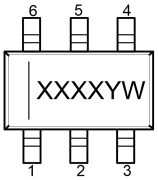
系统框图



Selection Guide/选型指南

- **Type Number/型号**

  BM210-XXXX-ST

Symbol 符号	Meaning 含义	Top View 俯视图
XXXX	Product Name 产品名称	
YW	Lot Number 批次编号	

Type Number Option/型号选择

Through choosing the "**XXXX**", the Overcharge Detection Threshold Voltage (**V_{OC}1, 2**) , the Overdischarge Detection Threshold voltage (**V_{OD}1,2**), and their accuracy of BM210 can be decided.

通过选择"XXXX"确定过充阈值(**V_{OC}1, 2**)，过放阈值(**V_{OD}1,2**) 和相应的精度。

Table 1. (@ 25℃)

Type Number 型号	Overcharge detection voltage 过充电检测电压 (V_{OC})	Overcharge hysteresis voltage 过充电恢复电压 (V_{OCR})	Over discharge detection voltage 过放电检测电压 (V_{OD})	Over discharge hysteresis voltage 过放电恢复电压 (V_{ODR})	Discharge overcurrent detection Voltage 放电过流检测电压 (V_{DOC})	Charge overcurrent detection voltage 充电过流检测电压 (V_{COC})	Short Circuit Detection Delay Time 短路延时 (T_{SHORT})	Auto wake up Function 休眠自恢复	Mark 标记
BM210-AJEA-ST	4.425V	4.225V	2.500V	3.000V	0.150V	-0.150V	256us	NO	AJEA YW
BM210-BJFA-ST	3.650V	3.450V	2.500V	3.000V	0.200V	-0.200V	256us	NO	BJFA YW
BM210-CKFB-ST	4.475V	4.275V	2.600V	2.950V	0.200V	-0.200V	256us	YES	CKFB YW
BM210-LEFA-ST	4.280V	4.080V	2.250V	2.950V	0.200V	-0.200V	256us	NO	LEFA YW
BM210-UNFB-ST	4.280V	4.080V	2.800V	3.000V	0.200V	-0.200V	256us	YES	UNFB YW
BM210-RJFA-ST	4.200V	4.100V	2.500V	3.000V	0.200V	-0.200V	256us	NO	RJFA YW
BM210-TJEA-ST	4.250V	4.050V	2.500V	3.000V	0.150V	-0.150V	256us	NO	TJEA YW
BM210-TPEA-ST	4.250V	4.150V	3.000V	3.000V	0.200V	-0.200V	256us	NO	TPEA YW
BM210-VNEA-ST	4.300V	4.100V	2.800V	3.000V	0.150V	-0.150V	256us	NO	VNEA YW

Remark: Please contact our sales office for the products with detection voltage value other than those specified above.

备注： 需要上述检测电压值以外的产品时，请与本公司营销部联系。

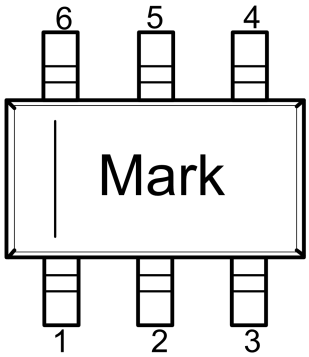
Pin Description

管脚定义

Table 2. SOT23-6L

Pin 引脚	Symbol 符号	Description 描述
1	DO	FET gate connection pin for discharge control, CMOS output 放电控制端子，CMOS 输出
2	CO	FET gate connection pin for charge control, CMOS output 充电控制端子，CMOS 输出
3	VM	Voltage detection pin between VM and VSS, Overcurrent detection pin 充、放电过流检测端子
4	VC	Input Pin of the center voltage between two-cell 两节电池中间电压的输入管脚
5	VDD	Power supply 供电电源
6	VSS	Ground 地

Top Side:
俯视图



Electrical Characteristic [1*] /电气参数

(T_{OPT}=25℃ unless otherwise specified)

Symbol 符号	Item 项目	Condition 条件	Min. 最小值	Typ. 典型值	Max. 最大值	Unit
$V_{OC}1,2$ [2*]	Overcharge Detection Voltage 1,2 过充电检测电压 1,2		V_{OC}1,2-0.025	V_{OC}1,2	V_{OC}1,2+0.025	V
$V_{OCR}1,2$ [2*]	Overcharge Release Voltage 1,2 过充电解除电压 1,2		V_{OCR}1,2-0.050	V_{OCR}1,2	V_{OCR}1,2+0.050	V
$V_{OD}1,2$ [2*]	Overdischarge Detection Voltage 1,2 过放电检测电压 1,2		V_{OD}1,2-0.080	V_{OD}1,2	V_{OD}1,2+0.080	V
$V_{ODR}1,2$ [2*]	Overdischarge Release Voltage 1,2 过放电解除电压 1,2		V_{ODR}1,2 -0.100	V_{ODR}1,2	V_{ODR}1,2+0.100	V
V_{DOC}[2*]	Discharge Overcurrent Detection Voltage 放电过电流检测电压	V1=V2 =3.300V	V_{DOC}-0.030	V_{DOC}	V_{DOC}+0.030	V
V_{SHORT}[2*]	Short Circuit Detection Voltage 短路检测电压	V1=V2 =3.300V	0.800	1.000	1.200	V
V_{COC}[2*]	Charge Overcurrent Detection Voltage 充电过电流检测电压	V1=V2 =3.300V	V_{COC}-0.030	V_{COC}	V_{COC}+0.030	V
V_{CHA}[2*]	Charger Detection Voltage 充电器检测电压	V1=V2 =3.300V	V_{COC}-0.030	V_{COC}	V_{COC}+0.030	V
V_{0CHA}	0V Battery Charge Starting Charger Voltage 电池 0V 可充充电器电压	V1=V2 =0.000V	1.2	-	-	V
T_{OC}	Overcharge Detection Delay Time 过充电检测延时时间	V1=V2 =4.500V	600	1000	1400	ms
T_{OD}	Over Discharge Detection Delay Time 过放电检测延时时间	V1=V2 =1.900V	76.8	128	179.2	ms
T_{DOC}	Discharge Overcurrent Detection Delay Time 放电过电流检测延时时间	V1=V2 =3.300V	6	10	14	ms
T_{SHORT}	Short Circuit Detection Delay Time(optional) 短路检测延时时间（可选）	V1=V2=3.300V	128	256	384	us
			256	512	768	us
T_{COC}	Charge Overcurrent Detection Delay Time 充电过电流检测延时时间	V1=V2=3.300V	4.8	8	11.2	ms
$V_{CO(H)}$	CO "H" Voltage CO 端子高电平电压	V1=V2=3.300V,Ioh=50uA	6.05	6.35		V
$V_{CO(L)}$	CO "L" Voltage CO 端子低电平电压	V1=V2=4.500V ,Iol=50uA		1.5	1.8	V
$V_{DO(H)}$	DO "H" Voltage DO 端子高电平电压	V1=V2=3.300V,Ioh=50uA	6.05	6.35		V
$V_{DO(L)}$	DO "L" Voltage DO 端子低电平电压	V1=V2=1.900V,Iol=50uA		0.4	0.7	V
R_{VMD}	Resistance Between VM And VDD VM 端子和 VDD 端子之间的电阻	V1=V2=1.900V，VM=0V	550	1100	1650	KΩ
R_{VMS}	Resistance Between VM And VSS VM 端子和 VSS 端子之间的电阻	V1=V2=3.300V，VM=1V	3	10	40	KΩ
I_{OPE}	Current Consumption During Normal State 正常工作状态下的消耗电流	V1=V2 =3.300V		5	9	uA
$I_{STANDBY}$	Standby Current (for products without Auto wake up) 休眠消耗电流（休眠不自恢复的产品）	V1=V2 =1.900V		0.2	0.50	uA
$I_{STANDBY}$	Standby Current (for products with Auto wake up) 休眠消耗电流（休眠自恢复的产品）	V1=V2 =1.900V		2.2	4	uA

1* The Electrical parameters for this temperature range is guaranteed by design, not tested in production.
此温度电器特性为设计保证值，并非实际测试值。

2* See "Selection Guide" section.
见"选型指南"部分。

Electrical Characteristic [1*] /电气参数

(T_{OPT}=-40~85℃ unless otherwise specified)

Symbol	Item	Condition	Min.	Typ.	Max.	Unit
$V_{OC}1,2$ [2*]	Overcharge Detection Voltage 1,2 过充电检测电压 1,2		V_{OC}1,2-0.050	V_{OC}1,2	V_{OC}1,2+0.050	V
$V_{OC}1,2$ [2*]	Overcharge Release Voltage 1,2 过充电解除电压 1,2		V_{OCR}1,2-0.070	V_{OCR}1,2	V_{OCR}1,2+0.070	V
$V_{OD}1,2$ [2*]	Overdischarge Detection Voltage 1,2 过放电检测电压 1,2		V_{OD}1,2-0.100	V_{OD}1,2	V_{OD}1,2+0.100	V
$V_{ODR}1,2$ [2*]	Overdischarge Release Voltage 1,2 过放电解除电压 1,2		V_{ODR}1,2 -0.120	V_{ODR}1,2	V_{ODR}1,2+0.120	V
V_{DOC} [2*]	Discharge Overcurrent Detection Voltage 放电过电流检测电压	V1=V2 =3.300V	V_{DOC}-0.040	V_{DOC}	V_{DOC}+0.040	V
V_{SHORT}	Short Circuit Detection Voltage 短路检测电压	V1=V2 =3.300V	0.400	1.000	1.400	V
V_{COC} [2*]	Charge Overcurrent Detection Voltage 充电过电流检测电压	V1=V2 =3.300V	V_{COC}-0.050	V_{COC}	V_{COC}+0.050	V
V_{CHA} [2*]	Charger Detection Voltage 充电器检测电压	V1=V2 =3.300V	V_{COC}-0.050	V_{COC}	V_{COC}+0.050	V
V_{0CHA}	0V Battery Charge Starting Charger Voltage 电池 0V 可充充电器电压	V1=V2 =0.000V	1.2	-	-	V
T_{OC}	Overcharge Detection Delay Time 过充电检测延时时间	V1=V2 =4.500V	400	1000	1600	ms
T_{OD}	Over Discharge Detection Delay Time 过放电检测延时时间	V1=V2 =1.900V	51.2	128	204.8	ms
T_{DOC}	Discharge Overcurrent Detection Delay Time 放电过电流检测延时时间	V1=V2 =3.300V	4	10	16	ms
T_{SHORT}	Short Circuit Detection Delay Time(optional) 短路检测延时时间（可选）	V1=V2=3.300V	102.4	256	409.6	us
			204.8	512	819.2	us
T_{COC}	Charge Overcurrent Detection Delay Time 充电过电流检测延时时间	V1=V2=3.300V	3.2	8	12.8	ms
$V_{CO(H)}$	CO "H" Voltage CO 端子高电平电压	V1=V2=3.300V, Ioh=50uA	5.85	6.35		V
$V_{CO(L)}$	CO "L" Voltage CO 端子低电平电压	V1=V2=4.500V;Iol=50uA		1.5	2.0	V
$V_{DO(H)}$	DO "H" Voltage DO 端子高电平电压	V1=V2=3.300V;Ioh=50uA	5.85	6.35		V
$V_{DO(L)}$	DO "L" Voltage DO 端子低电平电压	V1=V2=1.800V;Iol=50uA		0.4	0.9	V
R_{VMD}	Resistance Between VM And VDD VM 端子和 VDD 端子之间的电阻	V1=V2=1.900V;VM=0V	250	1100	2200	KΩ
R_{VMS}	Resistance Between VM And VSS VM 端子和 VSS 端子之间的电阻	V1=V2=3.300V;VM=1V	2	10	60	KΩ
I_{OPE}	Current Consumption During Normal State 正常工作状态下的消耗电流	V1=V2 =3.300V		5	15	uA
$I_{STANDBY}$	Standby Current (for products without Auto wake up) 休眠消耗电流（休眠不自恢复的产品）	V1=V2 =1.900V		0.2	1.0	uA
$I_{STANDBY}$	Standby Current (for products with Auto wake up) 休眠消耗电流（休眠自恢复的产品）	V1=V2 =1.900V		2.2	5	uA

1* The Electrical parameters for this temperature range is guaranteed by design, not tested in production.
此温度电器特性为设计保证值，并非实际测试值。

2* See "Selection Guide" section.
见"选型指南"部分。

Function Description /功能描述

1 · Normal Condition: /正常状态

When both VC and (VDD-VC) are between the Overdischarge Detection Threshold Voltage (V_{OD}) and the Overcharge Detection Threshold Voltage (V_{OC}), and the VM pin voltage between the Charger Detection Threshold Voltage (V_{CHA}) and the Discharge Overcurrent Detection Threshold Voltage (V_{DOC}), the outputs of DO pin and CO pin are on high level, making the charge and discharge MOSFETs on. Charging and discharging can be carried out freely.

当 VC 和（VDD-VC）电压介于过放电检测电压(V_{OD})和过充电检测电压(V_{OC})之间，并且 VM 端的电压介于充电过流检测电压(V_{CHA})与放电过流检测电压(V_{DOC})之间，那么 DO 端子与 CO 端子的点位为高电平，此时充放电 MOSFET 均处于开启状态，充放电可以自由进行。

2 · Overcharge Condition: /过充电状态

During charging, when VC or (VDD – VC) increases higher than V_{OC} and takes the Overcharge Detection Delay Time (T_{OC}) or longer, the output of CO pin will change from high level to low level, turning off the charging control FET to stop charging.

在正常充电状态下，当 VC 或（VDD-VC）电压上升至超过 V_{OC} 并维持时间达到或超过过充电检测延时(T_{OC})，CO 端子的输出电平会从高电平跳到低电平，从而关闭充电 MOSFET 停止充电。

3 · Overcharge Protection Release Condition: /过充电解除状态

The output of CO pin will change to high level, making charging recovered, when either of the following conditions come into being:

(1) both VC and (VDD – VC) become lower than the Overcharge Release Voltage (V_{OCR});

(2) a load connects to VDD after a charger is disconnected from the battery pack, and both VC and (VDD – VC) are lower than V_{OC}.

在以下任一状态下，CO 端子的输出将跳至高电平，允许继续充电：

(1) VC 和（VDD –VC）电压均低于过充电解除电压(V_{OCR})；

(2) 断开充电器后，如果连接有负载，VC 和（VDD-VC）的电压均低于 V_{OC}。

4 · Overdischarge Condition: /过放电状态

During discharging, when VC or (VDD – VC) decreases lower than V_{OD} and taking the Overdischarge Detection Delay Time (T_{OD}) or longer, the output of DO pin will change from high level to low level, turning off the discharging control FET to stop discharging.

在放电过程中，当 VC 或（VDD-VC）的电压降到 V_{OD} 以下，且持续时间超过过放电检测延时(T_{OD})，DO 端子电位变为低电平，关断放电 MOSFET 停止放电。

5． Overdischarge Protection Release Condition: /过放电解除状态

The output of DO pin will change to high level, making discharging recovered, when either of the following conditions come into being:

(1) a charger is connected to the battery pack, and the battery supply voltage becomes higher than V_{OD}, and VM is higher than the Charger Detection Threshold Voltage (V_{CHA});

(2) both the VC and (VDD－VC) become higher than the Overdischarge Release Voltage (V_{ODR}) and VM is between V_{CHA} and V_{DOC}.

在以下任一状态下，DO 端子的输出将跳至高电平，允许继续充电：

(1) 连接上充电器，电池电压高于 V_{OD}，并且 VM 电位高于充电器检测阈值电压(V_{CHA})；

(2) VM 端电位在 V_{CHA} 和 V_{DOC} 之间，VC 和（VDD-VC）的电压都高于过放电解除电压。

6． Discharge Overcurrent Protection: /放电过电流保护

During discharging, the current varies with load, and VM increases with the rise of the discharging current. Once VM rises higher than the Discharge Overcurrent Detection Threshold Voltage (V_{DOC}) and stays longer than the Discharge Overcurrent Detection Delay Time (T_{DOC}), DO pin changes from high to low level, turning off the discharging control FET. Once that Discharge Overcurrent state is removed, i.e. VM＜V_{DOC}, and the circuit recovers to normal state.

在放电过程中，电流大小与负载有关，而 VM 电压随着放电电流的增加而升高。当 VM 电位高于放电过电流检测电压(V_{DOC})，并持续时间长于放电过流检测延时(T_{DOC})，DO 端子电位变为低电位关断放电 MOS。一旦放电过电流状态解除，例如：当 VM＜V_{DOC}，电路恢复到正常工作状态。

7． Short Circuit Protection:/短路保护

This function has the same principle as the Discharge Overcurrent protection. But, the delay time T_{SHORT} is far shorter than T_{DOC}, and the threshold V_{SHORT} is far higher than V_{DOC}. When the circuit is shorted, VM increases rapidly. Once VM≥V_{SHORT} and stays longer than T_{SHORT}, DO pin switches to low, turning off the discharging control FET. After the short circuit state is removed, and VM＜V_{DOC}, the circuit recovers to the normal state. The short circuit peak current is related to V_{SHORT} and the ON resistance of the two FETs in series.

短路保护机制和放电过电流保护机制相同。但是短路检测延时 T_{SHORT} 远比 T_{DOC} 小，短路检测电压 V_{SHORT} 也远比 V_{DOC} 大。当电路发生短路，VM 的电压迅速上升，当 VM≥V_{SHORT}, DO 端经 T_{SHORT} 后变为低电位关断放电控制 FET。在短路状态解除后，并且 VM＜V_{DOC}，电路恢复到正常工作状态。短路保护的最大电流取决于 V_{SHORT} 和充放电 FETs 的导通电阻。

8． Charge Overcurrent Condition:/充电过流状态

If the VM pin voltage falls below the Charge Overcurrent Detection Threshold Voltage (V_{COC}) during charging under normal condition and takes the Charge Overcurrent Detection Delay Time (T_{COC}) or longer, the charging control FET is turned off and charging stops. This action is called the Charge Overcurrent Detection. Charge Overcurrent detection works when the DO pin voltage is "H" and the VM pin voltage falls below the Charge Overcurrent Detection Threshold Voltage (V_{COC}). To an Overdischarged battery, only when charging makes the battery voltage higher than the Overdischarge Detection Threshold, the Charge Overcurrent Detection can act. Charge Overcurrent state is released, once the voltage difference between VM pin and VSS pin becomes bigger than the Charge Overcurrent Detection Threshold Voltage (V_{COC}) value.

正常充电过程中，如果 VM 的电压降到充电过电流阈值电压(V_{COC})以下，并且持续时间超过充电过流检测延时(T_{COC})，充电 FET 会关闭停止充电。这个功能就是充电过流检测。充电过流保护只能发生在 DO 端为高电平并且 VM 端电压低于充电过流检测电压(V_{COC})的状态下。对于一个过放状态的电池，只有在其电压充到过放电检测电压以上，DO 端电位恢复到高电平后，充电过流保护功能才被释放，此时一旦检测到 VM-VSS 的电压低于充电过流检测阈值电压(V_{COC})，则会进入充电过流保护状态。

9． Charger Detect Condition:/充电器检测状态

A two-cell battery in Overdischarge condition can be released, when it is connected to a charger, the VM pin voltage is lower than the Charge Overcurrent Detection Threshold Voltage (V_{COC}), and each cell voltage becomes higher than the Overdischarge Detection Threshold Voltage (V_{OD}). This action is called Charger Detection. But, if the VM pin voltage is between the Charge Overcurrent Detection Threshold Voltage (V_{COC}) and the Discharge Overcurrent Detection Threshold Voltage (V_{DOC}), the Overdischarge state is not released unless the two cell voltages both become higher than the Overdischarge Release Voltage (V_{ODR}).

当电路连接上充电器，VM 端电压比充电过流检测电压(V_{COC})低，并且两节电池的电压都高于过放电检测电压(V_{OD})时，电路解除过放电状态。这个过程就是充电器检测。但是 VM 端电压在充电过电流检测电压(V_{COC})和放电过电流检测电压(V_{DOC})之间时，只有两节电池电压均高于过放电解除电压(V_{ODR})才会解除过放电状态。

10． 0V battery charge function:/0V 电池充电功能

This function is used to recharge the connected battery whose voltage is 0V due to the self-discharge. When the 0 V battery charge starting charger voltage (V0cha) or higher is applied between P+ and P− pins (see the Typical Application Circuits of Page1) by connecting a charger, the charging control FET gate is fixed to VDD pin voltage. When the voltage between the gate and source of the charging control FET becomes equal to or higher than the turn-on voltage by the charger voltage, the charging control FET turns on to start charging. At this time, the discharging control FET is off and the charging current flows through the internal parasitic diode in the discharging control FET. When the battery voltage becomes equal to or higher than the Overdischarge Detection voltage (V_{OD}1,2), the IC enters the normal condition.

0V 充电功能用于当电池由于自耗电而自身电压降到 0V 时。当电池连接的充电器电压高于 0V 充电允许的充电器电压（V0cha）或更高时，充电控制 FET 门级固定到 VDD 电位。当充电控制 FET 的门级和源级之间的电压差达到阈值电压或以上时，充电控制 FET 打开，芯片开始进入可充电状态。这时虽然放电控制

FET 处于关断状态，电流从放电 FET 的体二极管通过。当两节电池的电压均达到或高于放电检测电压（$V_{OD}1,2$）时，IC 进入正常工作状态。

Absolute Maximum Ratings

绝对额定值

Item 项目	Symbol 符号	Pin 引脚	Rated Value 规格	Unit 单位
VDD-VSS Input Voltage VDD-VSS 输入电压	V_{DS}	VDD	VSS-0.30~VSS+10	V
VC-VSS Input Voltage VC-VSS 输入电压	Vcs	VC	VSS-0.30~VSS+5.0	V
VM pin Input Voltage VM 端输入电压	V_{VM}	VM	VDD-28~VDD+0.30	V
DO Pin Output Voltage DO 端输出电压	V_{DO}	DO	VSS-0.30~VC+0.30	V
CO Pin Output Voltage CO 端输出电压	V_{CO}	CO	VM-0.30~VDD+0.30	V
Power Dissipation 功耗	P_D	-----	300	mW
Operation Temperature 工作温度范围	T_{opr}	-----	-40~+85	℃
Storage Temperature 存储温度范围	T_{stg}	-----	-55~+125	℃

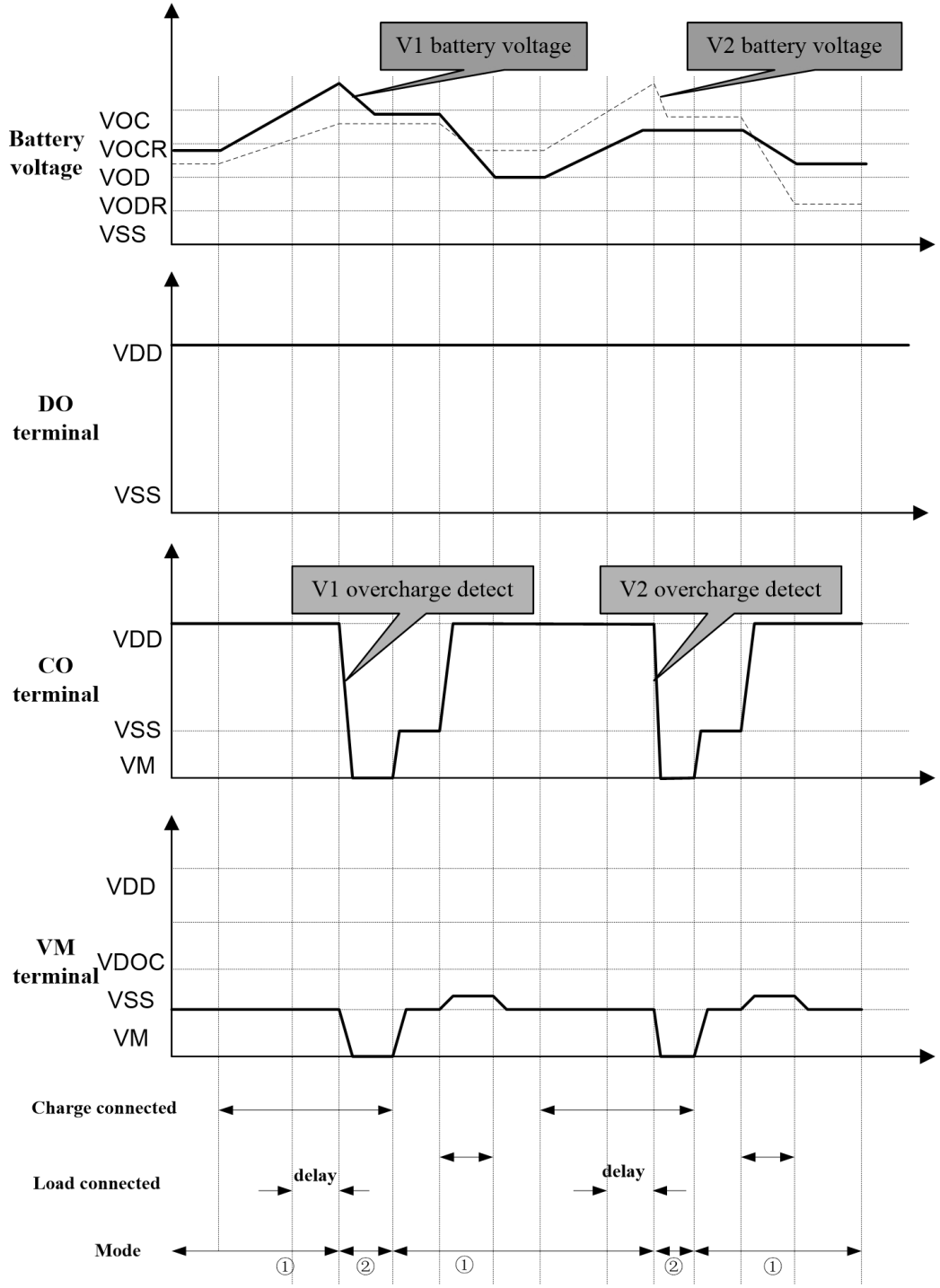
Attention: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

注意：超过“绝对额定值”的条件可能导致器件出现永久性损伤。长时间暴露在绝对额定值的环境下可能会影响器件的可靠性。

Operation Timing Charts:

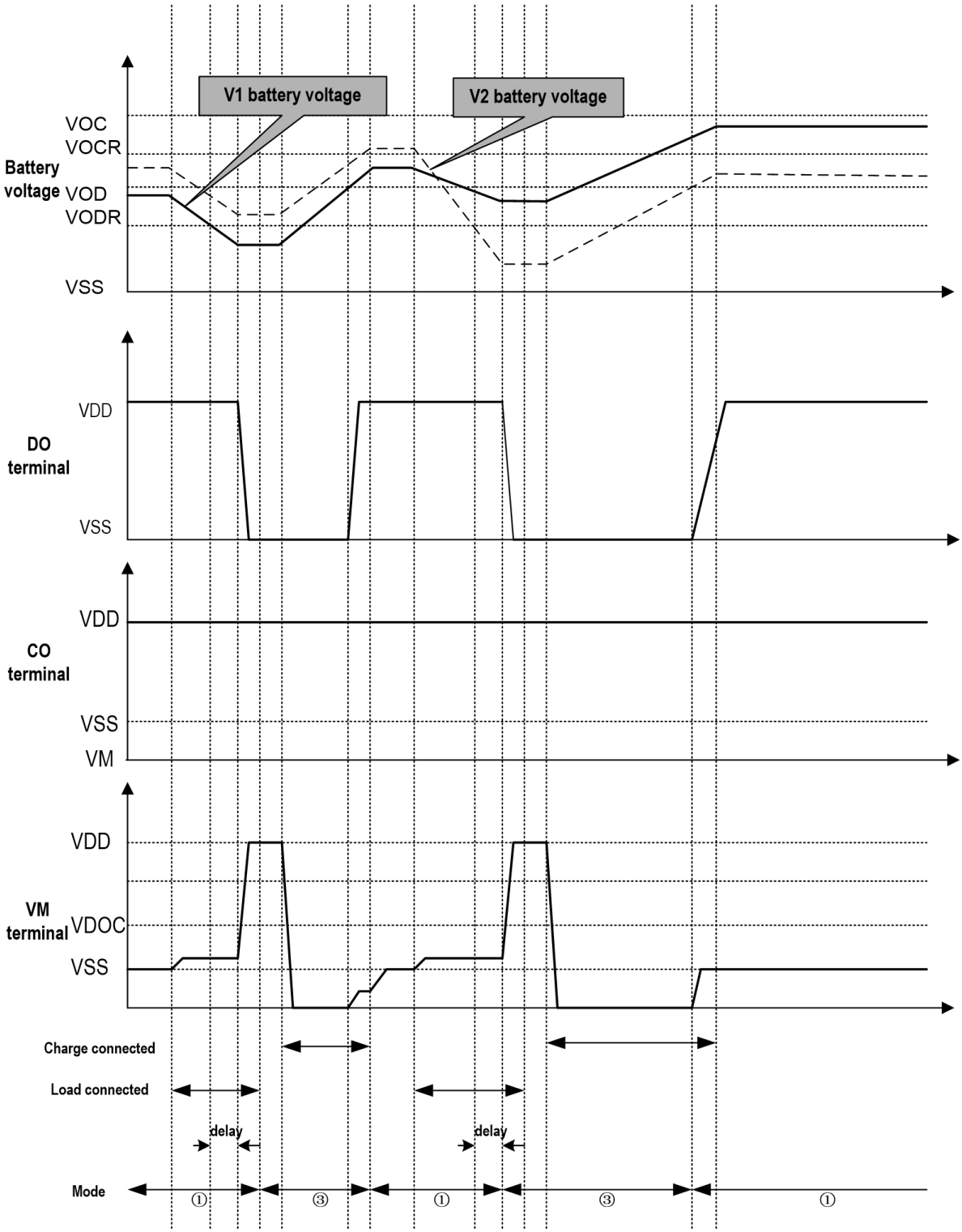
工作时序图

Overcharge detection: /过充电检测



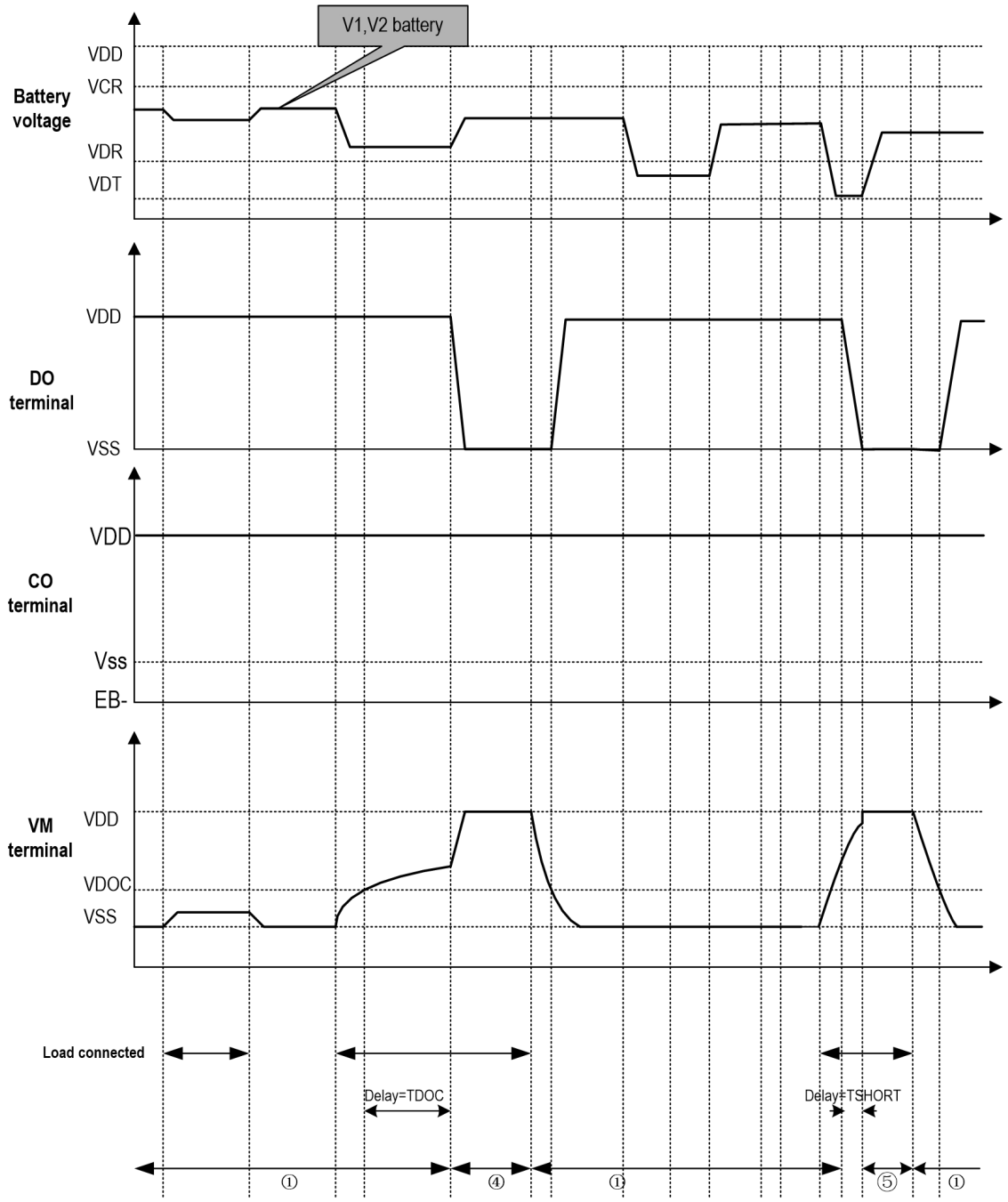
Note: ① Normal mode（正常状态） ② Overcharge mode （过充状态）

Overdischarge detection：/过放电检测



Note: ① Normal mode （正常状态）③ Overdischarge mode （过放状态）

Discharge Overcurrent/ Short Circuit Detection : /放电过电流/短路检测



Note: ① Normal mode（正常状态）
④ Discharge Overcurrent mode（放电过电流状态）
⑤ Short circuit mode （短路状态）

Test Circuits/测试电路

(1) Overcharge detection threshold voltage and overcharge release voltage (Test circuit 1)
过充电检测及过充电解除电压（测试电路 1）

Set V2=3.30V V3=0V, the Overcharge Detection Threshold Voltage ($V_{OC}1$) is the voltage between VDD and VC to which when V1 increases and keeps the condition for the Overcharge Detection Delay Time (T_{OC}), V_{CO} changes from “H” to “L”. The overcharge release voltage ($V_{OCR}1$) is the voltage between VDD and VC to which when V1 decreases, V_{CO} changes from “L” to “H”.
Set V1=3.30V V3=0V, the Overcharge Detection Threshold Voltage ($V_{OC}2$) is the voltage between VC and VSS to which when V2 increases and keeps the condition for the Overcharge Detection Delay Time (T_{OC}), V_{CO} changes from “H” to “L”. The Overcharge Release Voltage ($V_{OCR}2$) is the voltage between VC and VSS to which when V2 decreases, V_{CO} changes from “L” to “H”.
设置 V2=3.3V V3=0V，当 VDD-VC 电压 V1 上升并保持时间超过过充电检测延时(T_{OC})，CO 端电位从高电位变为低电位时的 V1 电压即为过充电检测电压($V_{OC}1$)。过充后，V1 逐渐下降，CO 端电位从低电位变为高电位的 V1 电压即为过充电解除电压($V_{OCR}1$)。
设置 V1=3.3V V3=0V，当 VC-VSS 电压 V2 上升并保持时间超过过充电检测延时(T_{OC})，CO 端电位从高电位变为低电位时的 V2 电压即为过充电检测电压($V_{OC}2$)。过充后，V2 逐渐下降，CO 端电位从低电位变为高电位的 V2 电压即为过充电解除电压($V_{OCR}2$)。

(2) Overdischarge detection threshold voltage and Overdischarge release voltage (Test circuit 1)
过放电检测和过放电解除电压（测试电路 1）

Set V2=3.30V V3=0V, the Overdischarge Detection Threshold Voltage ($V_{OD}1$) is the voltage between VDD and VC to which when V1 decreases and keep the condition for the Overdischarge Detection Delay Time (T_{OD}), VDO changes from “H” to “L”. The Overdischarge Release Voltage ($V_{ODR}1$) is the voltage between VC and VSS to which when V1 increases, VDO changes from “L” to “H”.
Set V1=3.30V V3=0V, the Overdischarge Detection Threshold Voltage ($V_{OD}2$) is the voltage between VC and VSS to which when V2 decreases and keep the condition for the Overdischarge Detection Delay Time (T_{OD}), VDO changes from “H” to “L”. The Overdischarge Release Voltage ($V_{ODR}2$) is the voltage between VC and VSS to which when V2 increases, VDO changes from “L” to “H”.
设置 V2=3.3V V3=0V，当 VDD-VC 电压 V1 下降并保持时间超过过放电检测延时(T_{OD})，DO 端电位从高电位变为低电位时的 V1 电压即为过放电检测电压($V_{OD}1$)。过放后，V1 逐渐上升，DO 端电位从低电位变为高电位的 V1 电压即为过放电解除电压($V_{ODR}1$)。
设置 V1=3.3V V3=0V，当 VDD-VC 电压 V2 下降并保持时间超过过放电检测延时(T_{OD})，DO 端电位从高电位变为低电位时的 V2 电压即为过放电检测电压($V_{OD}2$)。过放后，V2 逐渐上升，DO 端电位从低电位变为高电位的 V2 电压即为过放电解除电压($V_{ODR}2$)。

(3) Discharge Overcurrent detection threshold voltage and short circuit detection threshold voltage (Test circuit 1) /放电过电流检测电压和短路检测电压（测试电路 1）

Set V1=V2=3.300V, the Discharge Overcurrent 1 Detection Threshold Voltage (V_{DOC}) is the voltage V3 between VM and VSS to which when VM increases within 10 us and keep the condition for the Discharge Overcurrent Detection Delay Time (T_{DOC}), V_{DO} changes from “H” to “L”.
Threshold Voltage (V_{SHORT}) is the voltage V3 between VM and VSS to which when VM increases within 10us and keep the condition for the Short Circuit Detection Delay Time (T_{SHORT}), V_{DO} changes from “H” to “L”.

设置 V1=V2=3.3V，V3 在 10us 之内升高并保持时间超过放电过流检测延时(T_{DOC})，VDO 从“H”跳到“L”的 VM 对 VSS 电压即为放电过流检测电压（V_{DOC}）。
设置 V1=V2=3.3V，V3 在 10us 之内升高并保持时间超过放电过流检测延时(T_{SHORT})，VDO 从“H”跳到“L”的 VM 对 VSS 电压即为放电过流检测电压（V_{SHORT}）。

(4) Charger detection threshold voltage and Charge Overcurrent detection threshold voltage (Test circuit 1) /充电器检测及充电过流检测电压（测试电路 1）

In the Overdischarge condition, increase V2 gradually until it is between $V_{OD}2$ and $V_{ODR}2$. The voltage between VM and VSS to which when V3 decreases from 0V, V_{DO} changes from “L” to “H”, is the Charger Detection Threshold Voltage (V_{CHA}).
In the normal charging condition, the voltage between VM and VSS to which when V3 decreases from 0V, V_{CO} changes from “H” to “L” is the Charge Overcurrent Detection Threshold Voltage (V_{COC}). It has the same value as the Charger Detection Threshold Voltage (V_{CHA}).
在过放电状态下，缓慢增加 V2 到 $V_{OD}2$ 和 $V_{ODR}2$ 之间。电压 V3 从 0V 开始减小，V_{DO} 从“L”跳到“H”时的 VM-VSS 间电压即为充电器检测电压（V_{CHA}）。
在正常工作状态下，当 V3 电压从 0V 开始减小，V_{CO} 从“H”跳变到“L”时的 VM-VSS 间电压即为充电过电流检测电压（V_{COC}）。这个值和充电器检测电压(V_{CHA})相同。

(5) Normal operation current consumption and power down current consumption(Test circuit 2) 正常工作消耗电流及休眠消耗电流（测试电路 2）

Set V1=V2=3.30V, the current A1 flowing through VDD and Sense pin and the current A2 flowing through VC pin are the normal operation consumption current (I_{OPE}).
Set V1=1.80V V2=1.80V, the current A1 flowing through VDD and Sense pin and the current A2 flowing through VC pin are the power down current consumption (I_{PDN}).
设置 V1=V2=3.3V，流过 VDD 和检测端子的电流 A1 和流过 VC 端的电流 A2 是正常工作消耗电流(I_{OPE})。
设置 V1=1.8V V2=1.8V，流过 VDD 和检测端子的电流 A1 和流过 VC 端的电流 A2 是正常工作消耗电流(I_{PDN})。

(6) Overcharge detection delay time and Overdischarge detection delay time(Test circuit 3) 过充电检测延时及过放电检测延时（测试电路 3）

Set V3=0V, If V1 or V2 increases to be $V_{OC}1$ or over $V_{OC}1$ and keeps the condition for some time, V_{CO} will change from “H” to “L”. The time is called Overcharge Detection Delay Time (T_{OC}). It is used to judge whether overcharge happens indeed.
Set V3=0V, If V1 or V2 decreases to be $V_{OD}1$ or below $V_{OD}1$ and keeps the condition for some time, V_{DO} will change from “H” to “L”. The time is called Overdischarge Detection Delay Time (T_{OD}). It is used to judge whether Overdischarge happens indeed.
设置 V3=0V，如果 V1 或 V2 增加到 $V_{OC}1$ 或以上，并保持一段时间，V_{CO} 将从“H”跳变至“L”，这个时间是过充电检测延时(T_{OC})。这个过程可以用来判断过充电是否发生。
设置 V3=0V，如果 V1 或 V2 减小到 $V_{OD}1$ 或以下，并保持一段时间，V_{DO} 将从“H”跳变至“L”，这个时间是过放电检测延时(T_{OD})。这个过程可以用来判断过放电是否发生。

(7) Discharge Overcurrent detection delay time and short circuit detection delay time(Test circuit 3) 放电过电流检测延时与短路检测延时（测试电路 3）

Set V1=V2=3.300V, If V3 increases to be V_{DOC} or over V_{DOC} and keeps the condition for some time, V_{DO} will change from “H” to “L”. The time is called Discharge Overcurrent 1 Detection Delay Time (T_{DOC}). It is used to judge whether Discharge

Overcurrent happens indeed.

Set V1=V2=3.300V, If V3 increases to be V_{SHORT} or over V_{SHORT} and keeps the condition for some time, V_{DO} will change from “H” to “L”. The time is called Short Circuit Delay Time (T_{SHORT}). It is used to judge whether short circuit happens indeed.

设置 V1=V2=3.3V，如果 V3 增加到 V_{DOC} 及以上并保持一段时间，V_{DO} 将从“H”跳变至“L”。这个时间就是放电过电流检测延时(T_{DOC})。这个过程可以用来判断放电过电流是否发生。

设置 V1=V2=3.3V，如果 V3 增加到 V_{SHORT} 及以上并保持一段时间，V_{DO} 将从“H”跳变至“L”。这个时间就是放电过电流检测延时(T_{SHORT})。这个过程可以用来判断放电过电流是否发生。

(8) CO and DO output voltage(Test Circuit 4)/CO 和 DO 输出电压（测试电路 4）

Set V1=V2=3.40V, V3=0V, V5=0V, K1 on and K2 off,Increase V4 from 0V gradually, the V4 voltage when A2 = 50uA is the CO 'H' voltage ($V_{CO(H)}$).

Set V1=V2=4V, V3=0V, V5=0V, K1 on and K2 off, increase V4 from 0V gradually, the V4 voltage when A2 = - 50uA is the CO 'L' voltage ($V_{CO(L)}$).

Set V1=V2=3.40V, V4=0V, V5=0V, K1 off and K2 on, increase V3 from 0V gradually, the V4 voltage when A1 =50uA is the DO 'H' voltage ($V_{DO(H)}$).

Set V1=V2=1.80V, V4=0V, V5=0V, K1 off and K2 on, increase V3 from 0V gradually, the V3 voltage when A1= - 50uA is the DO 'L' voltage ($V_{DO(L)}$).

设置 V1=V2=3.4V，V3=0V，V5=0V，K1 开启 K2 关闭，从 0V 开始缓慢增加 V4，当 A2=50uA 时的 V4 电压是 CO“H”电压($V_{CO(H)}$)。

设置 V1=V2=4V，V3=0V，V5=0V，K1 开启 K2 关闭，从 0V 开始缓慢增加 V4，当 A2=-50uA 时的 V4 电压是 CO“L”电压($V_{CO(L)}$)。

设置 V1=V2=3.4V，V4=0V，V5=0V，K1 关闭启 K2 开启，从 0V 开始缓慢增加 V3，当 A1=50uA 时的 V4 电压是 DO“H”电压($V_{DO(H)}$)。

设置 V1=V2=1.8V，V4=0V，V5=0V，K1 关闭启 K2 开启，从 0V 开始缓慢增加 V3，当 A1=-50uA 时的 V4 电压是 DO“L”电压($V_{DO(L)}$)。

(9) Internal resistance VM –VDD and VM -VSS(Test circuit 4) /VM-VDD 和 VM-VSS 内阻（测试电路 4）

Set V1=V2=1.80V, V5=0V, K1 off and K2 off, (V1+V2)/I3 is the internal resistance R_{VMD}.

Set V1=V2=3.300V, V5=1V, K1 off and K2 off, V5/I3 is the internal resistance R_{VMS}.

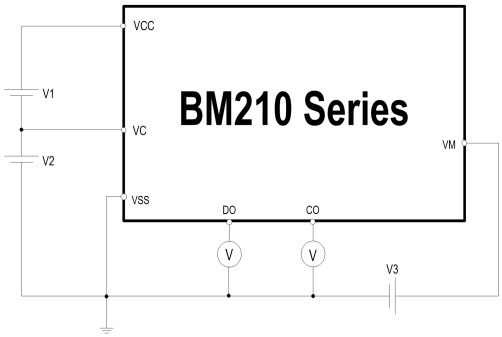
设置 V1=V2=1.8V，V5=0V，K1 关断 K2 关断，(V1+V2)/I3 是内阻 R_{VMD}。

设置 V1=V2=3.3V，V5=1V，K1 关断 K2 关断，V5/I3 是内阻 R_{VMS}。

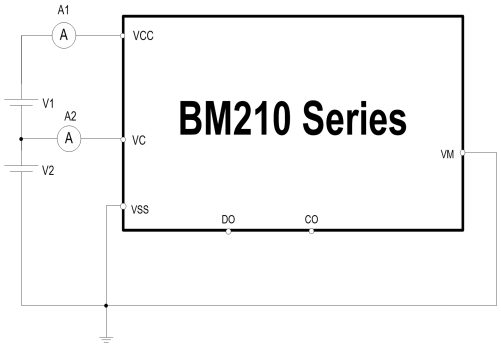
(10) 0V battery charge starting charger voltage (Test circuit 1) /0V 电池可充电的充电器电压（测试电路 1）

Set V1=V2=V3=0V and decrease V2 gradually. The voltage between VDD and VM when Vco goes “H”(VDD±0.2V) is the 0V battery charge starting charger voltage.

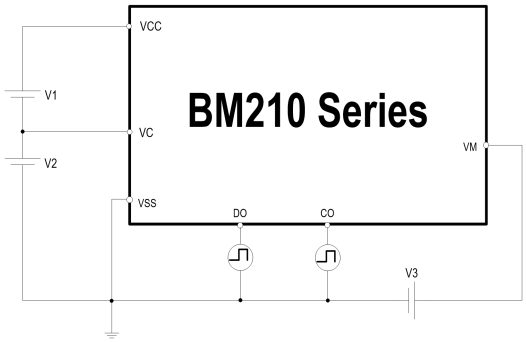
设置 V1=V2=V3=0V，降低 V3 电压，当 CO 电压 V_{CO} 从 V_{VM} 电位变为高电位（VDD±0.2V）时的 VDD-VM 电位差即为 0V 电池可充电的充电器电压。



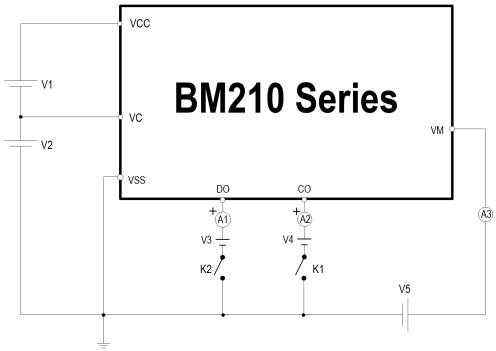
Circuit1
测试电路 1



Circuit2
测试电路 2



Circuit3
测试电路 3

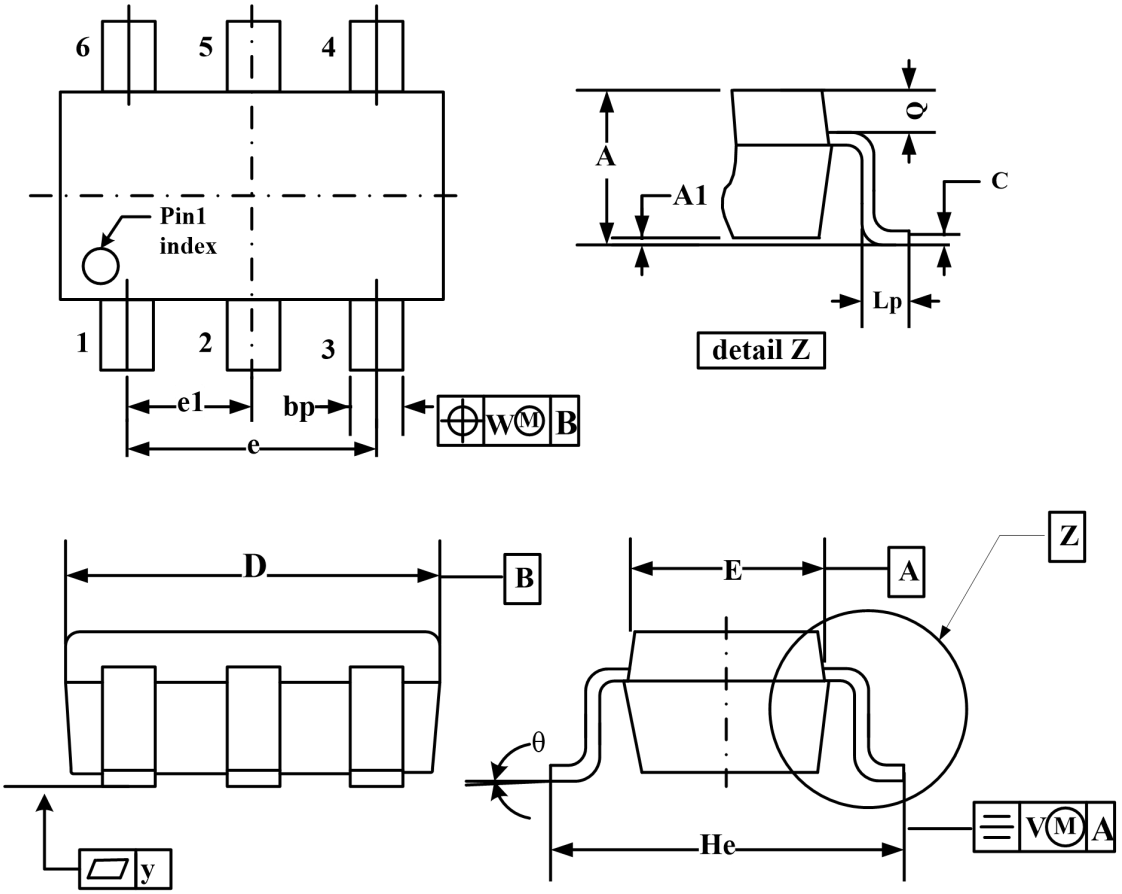


Circuit4
测试电路 4

Package

Package Outline:
封装外形

SOT23-6L



Dimensions (mm)

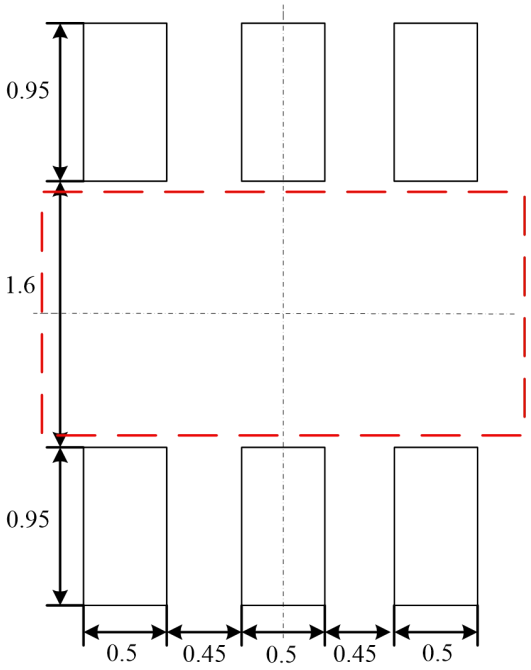
A	A1	bp	D	E	e	e1	He	Lp	Q	v	w	y	θ
1.3	0.15	0.5	3.1	1.7	1.9	0.95	3.0	0.6	0.33	0.2	0.2	0.1	0°
1.0	0.03	0.35	2.7	1.3			2.5	0.2	0.23				10°

PCB Layout

PCB 版图

SOT-23-6

Unit: mm



MBB packing / MBB 包装:

7" reel: pizza box 200mm * 200mm * 100mm； carton 420mm*420mm*320mm .3000PCS per reel
7 寸卷盘：小箱 200mm * 200mm * 100mm;大箱 420mm * 420mm * 320mm； 每盘 3000PCS

RESTRICTIONS ON PRODUCT USE
产品使用注意事项

- The information contained herein is subject to change without notice.
- BYD Semiconductor Company Limited exerts the greatest possible effort to ensure high quality and reliability. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing products, to comply with the standards of safety in making a safe design for the entire system, including redundancy, fire-prevention measures, and malfunction prevention, to prevent any accidents, fires, or community damage that may ensue. In developing your designs, please ensure that products are used within specified operating ranges as set forth in the most recent products specifications.
- The products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of products listed in this document shall be made at the customer's own risk.
- 本资料内容，随产品的改进，可能会有未经预告之修改。
- 比亚迪半导体股份有限公司尽最大能力保证产品高质量和可靠性。然而，半导体器件自发故障或者自身内部对物理冲击的电气敏感性和易损性而产生的失效。对于搭配应用本产品在火灾防护，自发灾难防护等安全防护设计系统中时可能出现的问题由用户负责。为了防止因为故障和错误而产生的人身事故，火灾事故等，请充分留意冗余设计、火灾蔓延对策设计、防止错误动作设计等安全设计。
- 此文本列出的产品适用于大众消费类产品（电脑、个人设备、办公设备、测量设备、工厂机器人、学术设备等）。产品不适用于需要高质量和可靠性、自身的故障可能导致人身伤害或伤亡的场合。不适用处包括原子能控制仪器、航空航天仪器、运输工具、交通信号控制仪器、燃烧控制仪器、医药设备和所有的安全设备等。在不适用场合使用本产品所导致的风险损失由客户自己负责。