CM1005-ZEKD 内置高精度电压检测电路和延迟电路，是用于锂离子、锂聚合物可充电电池的保护 IC。最适合于对 1 节锂离子、锂聚合物可充电电池组的过充电、过放电和过电流的保护。通过使用外接过电流检测电阻，实现受温度变化影响小的高精度过电流保护。

The CM1005-ZEKD is a protection IC for lithium-ion / lithium polymer rechargeable batteries and includes high-accuracy voltage detection circuits and delay circuits. It is suitable for protecting 1-cell lithium-ion / lithium polymer rechargeable battery packs from overcharge, overdischarge, and overcurrent. By using an external overcurrent detection resistor, the IC realizes high-accuracy overcurrent protection with less effect from temperature change.

■ 功能特点 / Features

1) 高精度电压检测功能 / High accuracy voltage detection

• 过充电保护电压 Overcharge detection voltage	4.630 V	Accuracy ±15 mV
• 过充电解除电压 Overcharge release voltage	4.430 V	Accuracy ±30 mV
• 过放电保护电压 Over discharge detection voltage	2.350 V	Accuracy ±35 mV
• 过放电解除电压 Over discharge release voltage	2.650 V	Accuracy ±65 mV
• 放电过流检测电压 Discharging overcurrent detection voltage	0.0120 V	Accuracy ±1.0 mV
• 负载短路检测电压 1 Load short-circuit detection voltage 1	0.0300 V	Accuracy ±5.0 mV
• 负载短路检测电压 2 Load short-circuit detection voltage 2	VDD-1.0 V	Accuracy ±0.3 V
• 充电过流保护电压 Charging overcurrent detection voltage	-0.0160 V	Accuracy ±1.0 mV

2) 各种检测延迟时间仅通过内置电路即可实现（不需要外接电容）
Detection delay times are generated only by an internal circuit (external capacitors are unnecessary)

3) 向 0V 电池充电功能 — 允许 / Enabled
0V battery charge function

4) 休眠功能 — 无 / N
Power-down function

5) 放电过流状态的解除条件 — 断开负载 / Load disconnection
Release condition of discharge overcurrent status

6) 放电过流状态的解除电压 — V_{RIOV}
Discharge overcurrent release voltage

7) 低电流消耗 / Ultra-low power dissipation

• 工作时 / Normal mode	2.0 μA (Typ.) (Ta = +25°C)
• 过放电时 / Overdischarge mode	0.5 μA (Typ.) (Ta = +25°C)

8）RoHS、无铅、无卤素 / RoHS, PB-Free, HF

■ 应用领域 / Application

- 单节锂离子/锂聚合物可充电电池
  Single-cell Li-ion / Li-Po rechargeable battery

■ 封装 / Package

- DFN1.9×1.6-6L

■ 系统功能框图 / Block Diagram

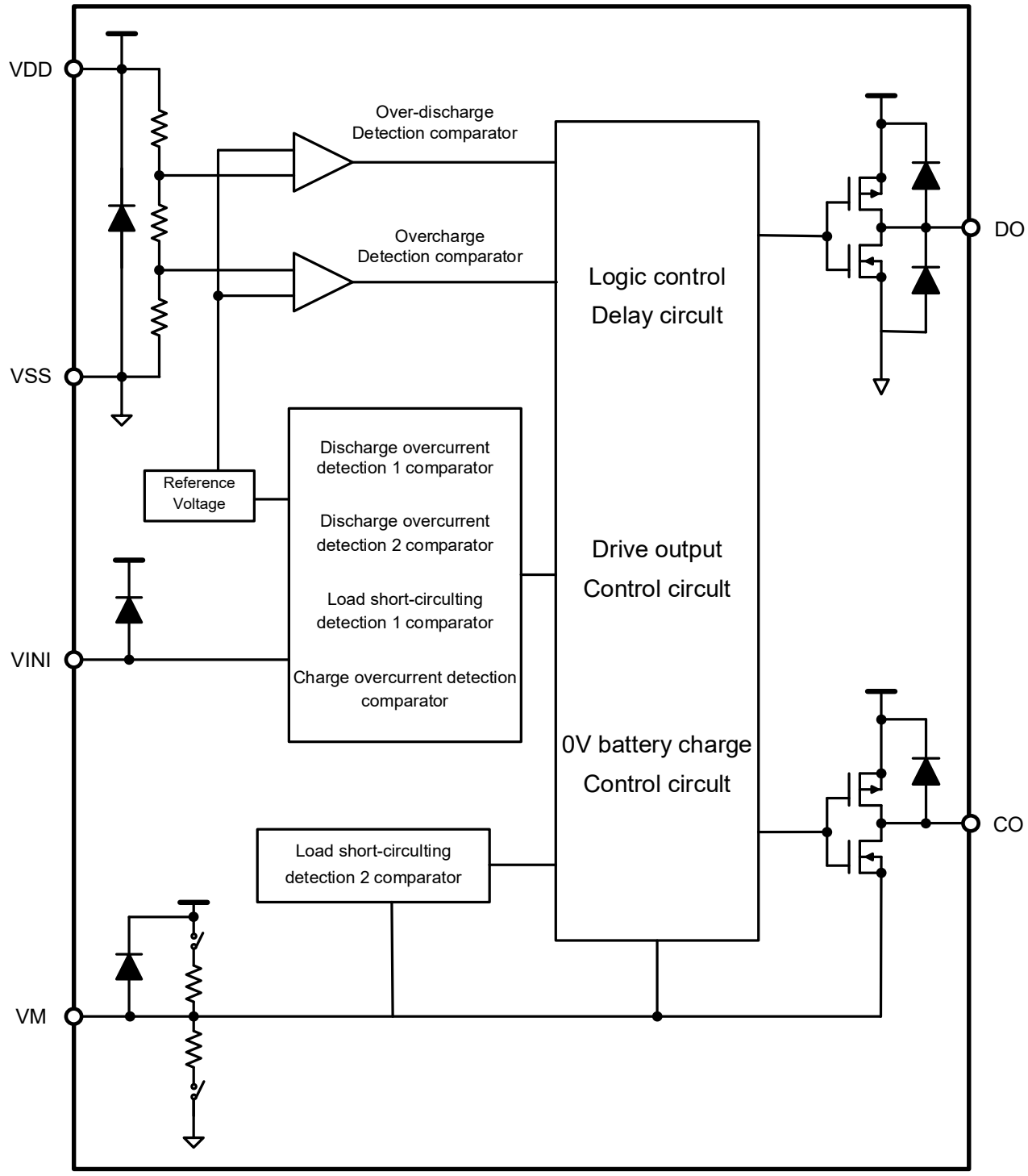


Figure 1

■ 引脚排列图 / Pin Configurations

DFN1.9×1.6-6L

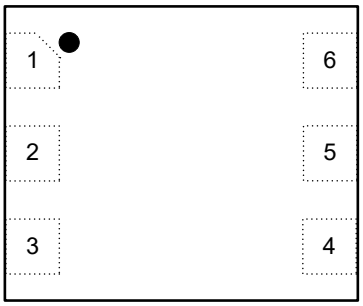


Figure 2 Top view

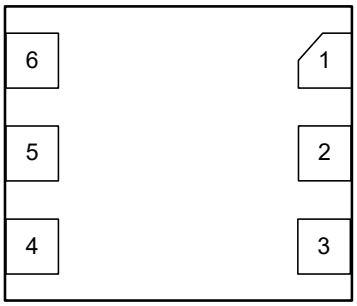


Figure 3 Bottom view

引脚号 Pin No.	符号 Symbol	描述 Description
1	VM	外部负电压输入端子 Input pin for external negative voltage
2	CO	充电 MOSFET 控制端子 Connection pin of charge control MOSFET gate
3	DO	放电 MOSFET 控制端子 Connection pin of discharge control MOSFET gate
4	VSS	电源接地端， 与供电电源(电池)的负极相连 Input pin for negative power supply
5	VDD	电源输入端， 与供电电源(电池)的正极连接 Input pin for positive power supply
6	VINI	过电流检测端子 Overcurrent detection pin

Table 1

■ 印字说明 / Marking

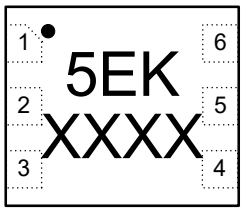


Figure 4

第一行：5 为产品系列代码，EK 为产品序列号

The first line: “5” is the product family code,“EK” is the Product Code

第二行：生产批次

The second line: lot number

■ 命名规则 / Naming rules

CM1005-ZEKD

封装代码 / Package outline Code

D：DFN1.9×1.6-6L

产品序列号 / Product Code

■ 产品列表 / Products Catalogue

1. 检测电压表 / Detect Voltage List

产品名称 Part No.	过充电保护电压 Overcharge detection voltage [V_{OC}]	过充电解除电压 Over-charge release voltage [V_{OCR}]	过放电保护电压 Over-discharge detection voltage [V_{OD}]	过放电解除电压 Over-discharge release voltage [V_{ODR}]	放电过流保护电压 Discharge overcurrent detection [V_{EC}]	短路保护电压 Short-circuit current detection [V_{SHORT1}]	充电过流保护电压 Charge overcurrent detection [V_{CHA}]
CM1005-ZEKD	4.630 V	4.430 V	2.350 V	2.650 V	0.0120 V	0.0300 V	-0.0160 V

Table 2

2. 产品功能表 / Product Function List

产品名称 Part No.	向 0V 电池充电功能 0V Battery Charge Function	放电过流状态解除条件 Release condition of discharge overcurrent status	放电过流状态解除电压 Release Voltage of Discharge Overcurrent Status	过充自恢复功能 Overcharge self-release Function	休眠功能 Power-down Function
CM1005-ZEKD	允许 Enabled	断开负载 Load disconnection	V_{RIOV}	有 Available	无 N

Table 3

3. 延迟时间 / Delay Time

过充电保护延时 Overcharge detection delay time [T_{OC}]	过放电保护延时 Over discharge detection delay time [T_{OD}]	放电过流延时 Discharge overcurrent detection delay time [T_{EC}]	充电过流延时 Charge overcurrent detection delay time [T_{CHA}]	短路延时 Load short-circuiting detection delay time [T_{SHORT}]
1024 ms	64 ms	32 ms	16 ms	280 μs

Table 4

备注：需要上述规格以外的产品时，请与本公司业务部门联系。

Remark: For more product info, please contact iCM marketing department.

■ 绝对最大额定值 / Absolute Maximum Ratings

(除特殊注明以外 : Ta = +25°C / Unless otherwise specified: Ta = +25°C)

项目 Item	符号 Symbol	绝对最大额定值 Ratings	单位 Unit
VDD 和 VSS 之间输入电压 Power supply voltage	VDD	VSS-0.3 ~ VSS+8.0	V
VINI 输入端子电压 Input pin voltage for VINI	V_{VINI}	VDD−8.0 ~ VDD+0.3	V
VM 输入端子电压 Input pin voltage for VM	V_{VM}	VDD-28 ~ VDD+0.3	V
CO 输出端子电压 CO output voltage	V_{CO}	V_{VM} -0.3 ~ VDD+0.3	V
DO 输出端子电压 DO output voltage	V_{DO}	VSS-0.3 ~ VDD+0.3	V
工作温度范围 Operating temperature	T_{OPR}	-40 ~ +85	°C
储存温度范围 Storage temperature	T_{STG}	-55 ~ +125	°C

Table 5

注意：所加电压超过绝对最大额定值，可能导致芯片发生不可恢复性损伤。

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.

■ 电气特性 / Electrical Characteristics

(除特殊注明以外 ：Ta = +25°C / Unless otherwise specified: Ta = +25°C)

项目 Item	符号 Symbol	测试条件 Test conditions	最小值 Min.	典型值 Typ.	最大值 Max.	单位 Unit
[功耗] / [Consumption]						
正常工作电流 Operating consumption	I_{OPE}	VDD=3.5V, V_{VM}= V_{VINI}=0V	0.9	2.0	3.6	μA
过放电流 Overdischarge consumption	I_{OPED}	VDD=V_{VM}=1.2V	-	0.5	0.8	μA
[检测电压] / [Detection Voltage]						
过充电保护电压 Overcharge detection voltage	V_{OC}	VDD=3.5 → 4.8V	4.615	4.630	4.645	V
过充电解除电压 Overcharge release voltage	V_{OCR}	-	4.400	4.430	4.460	V
过放电保护电压 Over discharge detection voltage	V_{OD}	VDD=3.5 → 2.0V	2.315	2.350	2.385	V
过放电解除电压 Over discharge release voltage	V_{ODR}	-	2.585	2.650	2.715	V
放电过电流检测电压 Discharge overcurrent detection voltage	V_{EC}	-	0.0110	0.0120	0.0130	V
负载短路检测电压 1 Load short-circuiting detection voltage 1	V_{SHORT1}	-	0.0250	0.0300	0.0350	V
负载短路检测电压 2 Load short-circuiting detection voltage 2	V_{SHORT2}	-	V_{VDD} − 1.3	V_{VDD} – 1.0	V_{VDD} − 0.7	V
充电过流保护电压 Charge overcurrent detection voltage	V_{CHA}	-	-0.0170	-0.0160	-0.0150	V
放电过流解除电压 Discharge overcurrent release voltage	V_{RIOV}	VDD=3.5V	V_{VDD} − 1.3	V_{VDD} – 1.0	V_{VDD} − 0.7	V
[延迟时间] / [Delay Time]						
过充电保护延时 Overcharge detection delay time	T_{OC}	VDD=3.5 → 4.8V	716	1024	1332	ms
过放电保护延时 Over discharge detection delay time	T_{OD}	VDD=3.5 → 2.0V	44.8	64	83.2	ms
放电过流保护延时 Discharge overcurrent detection delay time	T_{EC}	VINI-VSS=0→0.120V	22.4	32	41.6	ms
充电过流保护延时 Charge overcurrent detection delay time	T_{CHA}	VSS-VINI=0→0.120V	11.2	16	20.8	ms
负载短路保护延时 Load short-circuiting detection delay time	T_{SHORT}	VINI-VSS=0→0.120V	168	280	476	μs

过充电恢复延时 Overcharge detection release delay time	T_{OCR}	VDD=4.8 → 3.5V	0.7	1.0	1.3	ms
过放电恢复延时 Over discharge detection release delay time	T_{ODR}	VDD=2.0 → 3.5V	0.7	1.0	1.3	ms
放电过流恢复延时 Discharge overcurrent detection release delay time	T_{ECR}	VINI-VSS=0.120→0V	5.6	8.0	10.4	ms
充电过流恢复延时 Charge overcurrent detection release delay time	T_{CHAR}	VSS-VINI=0.120→0V	0.7	1.0	1.3	ms
[输入电压] / [Input voltage]						
VDD 端子-VSS 端子 VDD pin -VSS pin	V_{VDD}	-	1.5	-	8.0	V
VDD 端子-VM 端子 VDD pin -VM pin	V_{VM}	-	1.5	-	28	V
[内部电阻] / [Internal Resistance]						
VDD 端子-VM 端子间电阻 Resistance between VDD pin and VM pin	R_{VMD}	VDD=1.8V, V_{VM}=0V	125	250	600	kΩ
VM 端子-VSS 端子间电阻 Resistance between VM pin and VSS pin	R_{VMS}	VDD=3.4V, V_{VM}=1.0V	5	10	15	kΩ
[输出电阻] / [Output Resistance]						
CO 端子电阻“H” CO pin resistance "H"	R_{COH}	-	2.5	5	10	kΩ
CO 端子电阻“L” CO pin resistance "L"	R_{COL}	-	2.5	5	10	kΩ
DO 端子电阻“H” DO pin resistance "H"	R_{DOH}	-	2.5	5	10	kΩ
DO 端子电阻“L” DO pin resistance "L"	R_{DOL}	-	1	2	4	kΩ
[向 0V 电池充电的功能] / [0V Battery Charge Function]						
开始向 0 V 电池充电的充电器电压 0V battery charge “Enabled” starting charge voltage	V_{0CHA}	允许向 0V 电池充电 0V battery charging “Enabled”	0.7	1.1	1.5	V

Table 6

■ 电气特性 / Electrical Characteristics

(除特殊注明以外 ：Ta = -20°C ~ +60°C*1 / Unless otherwise specified: Ta = -20°C ~ +60°C*1)

项目 Item	符号 Symbol	测试条件 Test conditions	最小值 Min.	典型值 Typ.	最大值 Max.	单位 Unit
[功耗] / [Consumption]						
正常工作电流 Operating consumption	I_{OPE}	VDD=3.5V, V_{VM}= V_{VINI}=0V	0.9	2.0	4.1	μA
过放电流 Overdischarge consumption	I_{OPED}	VDD=V_{VM}=1.2V	-	0.5	1.0	μA
[检测电压] / [Detection Voltage]						
过充电保护电压 Overcharge detection voltage	V_{OC}	VDD=3.5 → 4.8V	4.610	4.630	4.650	V
过充电解除电压 Overcharge release voltage	V_{OCR}	-	4.375	4.430	4.485	V
过放电保护电压 Over discharge detection voltage	V_{OD}	VDD=3.5 → 2.0V	2.295	2.350	2.405	V
过放电解除电压 Over discharge release voltage	V_{ODR}	-	2.550	2.650	2.750	V
放电过电流检测电压 Discharge overcurrent detection voltage	V_{EC}	-	0.0105	0.0120	0.0135	V
负载短路检测电压 1 Load short-circuiting detection voltage 1	V_{SHORT1}	-	0.0245	0.0300	0.0355	V
负载短路检测电压 2 Load short-circuiting detection voltage 2	V_{SHORT2}	-	V_{VDD} − 1.5	V_{VDD} – 1.0	V_{VDD} − 0.5	V
充电过流保护电压 Charge overcurrent detection voltage	V_{CHA}	-	-0.0175	-0.0160	-0.0145	V
放电过流解除电压 Discharge overcurrent release voltage	V_{RIOV}	VDD=3.5V	V_{VDD} − 1.5	V_{VDD} – 1.0	V_{VDD} − 0.5	V
[延迟时间] / [Delay Time]						
过充电保护延时 Overcharge detection delay time	T_{OC}	VDD=3.5 → 4.8V	614	1024	1434	ms
过放电保护延时 Over discharge detection delay time	T_{OD}	VDD=3.5 → 2.0V	38.4	64	89.6	ms
放电过流保护延时 Discharge overcurrent detection delay time	T_{EC}	VINI-VSS=0→0.120V	19.2	32	44.8	ms
充电过流保护延时 Charge overcurrent detection delay time	T_{CHA}	VSS-VINI=0→0.120V	9.6	16	22.4	ms
负载短路保护延时 Load short-circuiting detection delay time	T_{SHORT}	VINI-VSS=0→0.120V	140	280	504	μs

过充电恢复延时 Overcharge detection release delay time	T_{OCR}	VDD=4.8 → 3.5V	0.6	1.0	1.4	ms
过放电恢复延时 Over discharge detection release delay time	T_{ODR}	VDD=2.0 → 3.5V	0.6	1.0	1.4	ms
放电过流恢复延时 Discharge overcurrent detection release delay time	T_{ECR}	VINI-VSS=0.120→0V	4.8	8.0	11.2	ms
充电过流恢复延时 Charge overcurrent detection release delay time	T_{CHAR}	VSS-VINI=0.120→0V	0.6	1.0	1.4	ms
[输入电压] / [Input voltage]						
VDD 端子-VSS 端子 VDD pin -VSS pin	V_{VDD}	-	1.5	-	8.0	V
VDD 端子-VM 端子 VDD pin -VM pin	V_{VM}	-	1.5	-	28	V
[内部电阻] / [Internal Resistance]						
VDD 端子-VM 端子间电阻 Resistance between VDD pin and VM pin	R_{VMD}	VDD=1.8V, V_{VM}=0V	80	250	700	kΩ
VM 端子-VSS 端子间电阻 Resistance between VM pin and VSS pin	R_{VMS}	VDD=3.4V, V_{VM}=1.0V	3.5	10	20	kΩ
[输出电阻] / [Output Resistance]						
CO 端子电阻“H” CO pin resistance "H"	R_{COH}	-	1	5	15	kΩ
CO 端子电阻“L” CO pin resistance "L"	R_{COL}	-	1	5	15	kΩ
DO 端子电阻“H” DO pin resistance "H"	R_{DOH}	-	1	5	15	kΩ
DO 端子电阻“L” DO pin resistance "L"	R_{DOL}	-	0.5	2	6	kΩ
[向 0V 电池充电的功能] / [0V Battery Charge Function]						
开始向 0 V 电池充电的充电器电压 0V battery charge “Enabled” starting charge voltage	V_{0CHA}	允许向 0V 电池充电 0V battery charging “Enabled”	0.5	1.1	1.7	V

Table 7

***1.并没有在高温以及低温的条件下进行筛选，因此只保证在此温度范围下的设计规格。**

***1：Since products are not screened at high and low temperature, the specification for this temperature range is guaranteed by design, not tested in production.**

■ 电气特性 / Electrical Characteristics

(除特殊注明以外 ：Ta = -40°C ~ +85°C*1 / Unless otherwise specified: Ta = -40°C ~ +85°C*1)

项目 Item	符号 Symbol	测试条件 Test conditions	最小值 Min.	典型值 Typ.	最大值 Max.	单位 Unit
[功耗] / [Consumption]						
正常工作电流 Operating consumption	I_{OPE}	VDD=3.5V, V_{VM}= V_{VINI}=0V	0.9	2.0	4.1	μA
过放电流 Overdischarge consumption	I_{OPED}	VDD=V_{VM}=1.2V	-	0.5	1.0	μA
[检测电压] / [Detection Voltage]						
过充电保护电压 Overcharge detection voltage	V_{OC}	VDD=3.5 → 4.8V	4.590	4.630	4.660	V
过充电解除电压 Overcharge release voltage	V_{OCR}	-	4.370	4.430	4.490	V
过放电保护电压 Over discharge detection voltage	V_{OD}	VDD=3.5 → 2.0V	2.290	2.350	2.410	V
过放电解除电压 Over discharge release voltage	V_{ODR}	-	2.550	2.650	2.750	V
放电过电流检测电压 Discharge overcurrent detection voltage	V_{EC}	-	0.0100	0.0120	0.0140	V
负载短路检测电压 1 Load short-circuiting detection voltage 1	V_{SHORT1}	-	0.0240	0.0300	0.0360	V
负载短路检测电压 2 Load short-circuiting detection voltage 2	V_{SHORT2}	-	V_{VDD} − 1.5	V_{VDD} – 1.0	V_{VDD} − 0.5	V
充电过流保护电压 Charge overcurrent detection voltage	V_{CHA}	-	-0.0180	-0.0160	-0.0140	V
放电过流解除电压 Discharge overcurrent release voltage	V_{RIOV}	VDD=3.5V	V_{VDD} − 1.5	V_{VDD} – 1.0	V_{VDD} − 0.5	V
[延迟时间] / [Delay Time]						
过充电保护延时 Overcharge detection delay time	T_{OC}	VDD=3.5 → 4.8V	512	1024	1536	ms
过放电保护延时 Over discharge detection delay time	T_{OD}	VDD=3.5 → 2.0V	32	64	96	ms
放电过流保护延时 Discharge overcurrent detection delay time	T_{EC}	VINI-VSS=0→0.120V	16	32	48	ms
充电过流保护延时 Charge overcurrent detection delay time	T_{CHA}	VSS-VINI=0→0.120V	8	16	24	ms
负载短路保护延时 Load short-circuiting detection delay time	T_{SHORT}	VINI-VSS=0→0.120V	112	280	504	μs

过充电恢复延时 Overcharge detection release delay time	T_{OCR}	VDD=4.8 → 3.5V	0.5	1.0	1.5	ms
过放电恢复延时 Over discharge detection release delay time	T_{ODR}	VDD=2.0 → 3.5V	0.5	1.0	1.5	ms
放电过流恢复延时 Discharge overcurrent detection release delay time	T_{ECR}	VINI-VSS=0.120→0V	4.0	8.0	12.0	ms
充电过流恢复延时 Charge overcurrent detection release delay time	T_{CHAR}	VSS-VINI=0.120→0V	0.5	1.0	1.5	ms
[输入电压] / [Input voltage]						
VDD 端子-VSS 端子 VDD pin -VSS pin	V_{VDD}	-	1.5	-	8.0	V
VDD 端子-VM 端子 VDD pin -VM pin	V_{VM}	-	1.5	-	28	V
[内部电阻] / [Internal Resistance]						
VDD 端子-VM 端子间电阻 Resistance between VDD pin and VM pin	R_{VMD}	VDD=1.8V, V_{VM}=0V	80	250	700	kΩ
VM 端子-VSS 端子间电阻 Resistance between VM pin and VSS pin	R_{VMS}	VDD=3.4V, V_{VM}=1.0V	3.5	10	20	kΩ
[输出电阻] / [Output Resistance]						
CO 端子电阻“H” CO pin resistance "H"	R_{COH}	-	1	5	15	kΩ
CO 端子电阻“L” CO pin resistance "L"	R_{COL}	-	1	5	15	kΩ
DO 端子电阻“H” DO pin resistance "H"	R_{DOH}	-	1	5	15	kΩ
DO 端子电阻“L” DO pin resistance "L"	R_{DOL}	-	0.5	2	6	kΩ
[向 0V 电池充电的功能] / [0V Battery Charge Function]						
开始向 0 V 电池充电的充电器电压 0V battery charge “Enabled” starting charge voltage	V_{0CHA}	允许向 0V 电池充电 0V battery charging “Enabled”	0.5	1.1	1.7	V

Table 8

***1.并没有在高温以及低温的条件下进行筛选，因此只保证在此温度范围下的设计规格。**

***1：Since products are not screened at high and low temperature, the specification for this temperature range is guaranteed by design, not tested in production.**

■ 功能描述 / Function Description

1. 正常工作状态 / Normal Condition

芯片是通过监视连接在 VDD 端子 －VSS 端子间的电池电压以及 VINI 端子 －VSS 端子间电压，来控制充电和放电。电池电压在过放电检测电压 (V_{OD}) 以上且在过充电检测电压 (V_{OC}) 以下的范围内、VINI 端子电压在充电过电流检测电压 (V_{CHA}) 以上且在放电过电流检测电压 (V_{EC}) 以下的范围内的情况下时，充电控制用 MOSFET 和放电控制用 MOSFET 的双方均被打开。这种状态称为通常状态，可以自由地进行充电和放电。

在通常状态下，没有连接 VDD 端子 －VM 端子间电阻 (R_{VMD}) 和 VM 端子 －VSS 端子间电阻 (R_{VMS})。

注意：初次连接电芯时，会有不能放电的可能性，此时，短接VM端子和VSS端子，或者连接充电器，即可恢复到正常工作状态。

The IC monitors the voltage of the battery connected between VDD pin and VSS pin, the voltage between VINI 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 VINI 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.

The resistance between VDD pin and VM pin (R_{VMD}), and the resistance between VM pin and VSS pin (R_{VMS}) are not connected in the normal status.

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. 过充电状态 / Overcharge Condition

在充电中，通常状态的电池电压若超过 V_{OC}，且这种状态保持在过充电检测延迟时间 (T_{OC}) 以上的情况下，会关闭充电控制用 MOSFET 而停止充电。这种状态称为过充电状态。

过充电状态的解除，分为如下的 2 种情况。

(1) 如果 VM 端子电压在低于 0.25 V (典型值) 的情况下，当电池电压降低到过充电解除电压 (V_{OCR}) 以下时，即可解除过充电状态。

(2) 如果 VM 端子电压在 0.25 V (典型值) 以上的情况下，当电池电压降低到 V_{OC} 以下时，即可解除过充电状态。

检测出过充电之后，连接负载开始放电，由于放电电流通过充电控制用 MOSFET 的内部寄生二极管流动，因此 VM 端子电压比 VSS 端子电压增加了内部寄生二极管的 Vf 电压。此时，如果 VM 端子电压在 0.25 V (典型值) 以上的情况下，当电池电压在 V_{OC} 以下时，即可解除过充电状态。

注意：对于超过VOC而被充电的电池，即使连接了较大值的负载，也不能使电池电压下降到VOC以下的情况下，在电池电压降低到VOC为止，放电过电流检测以及负载短路检测是不能发挥作用的。但是，实际上电池的内部阻抗有数十mΩ，在连接了可使过电流发生的较大值负载的情况下，因为电池电压会马上降低，因此放电过电流检测以及负载短路检测是可以发挥作用的。

When the battery voltage becomes higher than V_{OC} during charging in the normal status and the condition continues for the overcharge detection delay time (T_{OC}) or longer, 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 condition 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 0.25 V typ., the overcharge state is released when the battery voltage falls below overcharge release voltage (V_{OCR}).

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

When the discharge is started by connecting a load after the overcharge detection, the VM pin voltage rises by the Vf voltage of the parasitic diode than the VSS pin voltage, because the discharge current flows through the parasitic diode in the charge control MOSFET. If this VM pin voltage is equal to or higher than 0.25 V typ., the IC releases the overcharge status when the

battery voltage is equal to or lower than V_{OC}.

Note: If the battery is charged to a voltage higher than Voc and the battery voltage does not fall below Voc even when a heavy load is connected, discharge overcurrent detection and load short-circuiting detection do not function until the battery voltage falls below Voc. Since an actual battery has an internal impedance of tens of mΩ, the battery voltage drops immediately after a heavy load that causes overcurrent is connected, and discharge overcurrent detection and load short-circuiting detection function.

3. 过放电状态 / Over discharge Condition

当通常状态下的电池电压在放电过程中降低到 V_{OD} 之下，且这种状态保持在过放电检测延迟时间 (T_{OD}) 以上的情况下，会关闭放电控制用 MOSFET 而停止放电。这种状态称为过放电状态。

在过放电状态下，由于芯片内部的 VDD 端子 − VM 端子间可通过 R_{VMD} 来进行短路，因此 VM 端子会因 R_{VMD} 而被上拉。

(1) 在不连接充电器，VM 端子电压≥0.7 V (典型值) 的情况下，电池电压在 V_{ODR} 以上，解除过放电状态。

(2) 在连接充电器，0.25 V (典型值)<VM 端子电压<0.7 V (典型值) 的情况下，电池电压在 V_{ODR} 以上，解除过放电状态。

(3) 在连接充电器，VM 端子电压≤0.25 V (典型值)的情况下，电池电压在 V_{OD} 以上，解除过放电状态。

在过放电状态下，没有连接 R_{VMS}。

When the battery voltage falls below V_{OD} during discharging in the normal status and the condition continues for the overdischarge detection delay time (T_{OD}) or longer, the output voltage of DO will reverse. The discharge MOSFET will be turned off and stop discharging. This condition is called the overdischarge status.Under the overdischarge status, VDD pin and VM pin are shorted by R_{VMD} in the chip. The VM pin voltage is pulled up by R_{VMD}.

(1) When a battery is not connected to a charger and the VM pin voltage ≥ 0.7 V typ., the battery voltage reaches V_{ODR} or higher and the over discharge state is released.

(2) When a battery is connected to a charger and 0.25 V typ. < the VM pin voltage < 0.7 V typ., the battery voltage reaches V_{ODR} or higher and the over discharge state is released.

(3) When a battery is connected to a charger. the VM pin voltage ≤ 0.25 V typ., the battery voltage reaches V_{OD} or higher and the over discharge state is released.

4. 放电过电流状态 (放电过电流、负载短路 1、负载短路 2) / Discharge overcurrent status (discharge overcurrent, load short- circuiting 1, load short-circuiting 2)

4.1 放电过电流、负载短路 1 / Discharge overcurrent, load short-circuiting 1

处于通常状态下的电池，当放电电流达到所定值以上时，会导致 VINI 端子电压上升到 V_{EC} 以上，若这种状态持续保持在放电过电流检测延迟时间 (T_{EC}) 以上的情况下，会关闭放电控制用 MOSFET 而停止放电。这种状态称为放电过电流状态。

在放电过电流状态下，芯片内部的 VM 端子 － VSS 端子间可通过 R_{VMS} 来进行短路。但是，在连接着负载的期间，VM 端子电压由于连接着负载而变为 VDD 端子电压。若断开与负载的连接，则 VM 端子电压恢复回 VSS 端子电压。当 VM 端子电压降低到 V_{RIOV} 以下时，即可解除放电过电流状态。

在放电过电流状态下，没有连接 R_{VMD}。

When a battery in the normal status is in the status where the VINI pin voltage is equal to or higher than V_{EC} because the discharge current is equal to or higher than the specified value and the status lasts for the discharge overcurrent detection delay time (T_{EC}) or longer, the discharge control MOSFET is turned off and discharging is stopped. This status is called the discharge overcurrent status.

Under the discharge overcurrent status, VM pin and VSS pin are shorted by R_{VMS} in the chip. However, the VM pin voltage is the VDD pin voltage due to the load as long as the load is connected. When the load is disconnected, the VM pin returns to the VSS pin voltage. When the VM pin voltage returns to V_{RIOV} or lower, the discharge overcurrent status is released.

R_{VMD} is not connected in the discharge overcurrent status.

4.2 负载短路 2 / Load short-circuiting 2

处于通常状态下的电池，当连接能导致放电过电流发生的负载时，VM 端子电压上升到 V_{SHORT2} 以上的状态持续保持在负载短路检测延迟时间 (T_{SHORT}) 以上的情况下，会关闭放电控制用 MOSFET 而停止放电。这种状态称为放电过电流状态。放电过电流状态的解除方法与 "4. 1 放电过电流、负载短路 1" 相同。

When a battery in the normal status is in the status where a load causing discharge overcurrent is connected, and the VM pin voltage is equal to or higher than V_{SHORT2} and the status lasts for the load short-circuiting detection delay time (T_{SHORT}) or longer, the discharge control MOSFET is turned off and discharging is stopped. This status is called the discharge overcurrent condition. It releases the discharge overcurrent status in the same way as in "4. 1 Discharge overcurrent, load short-circuiting 1".

5. 充电过流状态 / Charging Overcurrent Condition

在通常状态下的电池，由于充电电流在额定值以上，会导致 VINI 端子电压降低到 V_{CHA} 以下，若这种状态持续保持在充电过电流检测延迟时间 (T_{CHA}) 以上的情况下，会关闭充电控制用 MOSFET 而停止充电。这种状态称为充电过电流状态。断开与充电器的连接，当放电电流流动，VM 端子电压上升到 0.25 V (典型值) 以上时，既可解除充电过电流状态。

在过放电状态下，充电过电流检测不发挥作用。

When a battery in the normal status is in the status where the VINI pin voltage is equal to or lower than V_{CHA} because the charge current is equal to or higher than the specified value and the status lasts for the charge overcurrent detection delay time (T_{CHA}) or longer, the charge control MOSFET is turned off and charging is stopped. This status is called the charge overcurrent status.

The charging overcurrent status is released. when the discharge current flows and the VM pin voltage is 0.25 V typ. or higher by removing the charger.

The charge overcurrent detection does not function in the overdischarge status.

6. 向 0V 电池充电功能（允许） / 0V Battery Charging Function “Enabled”

已被连接的电池电压因自身放电，在为 0 V 时的状态下开始变为可进行充电的功能。在 P+端子与 P−端子之间连接电压在向 0 V 电池充电开始充电器电压 (V_{0CHA}) 以上的充电器时，充电控制用 MOSFET 的门极会被固定为 VDD 端子电压。借助于充电器电压，当充电控制用 MOSFET 的门极和源极间电压达到阈值电压以上时，充电控制用 MOSFET 将被导通 (ON) 而开始进行充电。此时，

放电控制用 MOSFET 被截止 (OFF)，充电电流会流经放电控制用 FET 的内部寄生二极管而流入。在电池电压变为 V_{OD} 以上时恢复回通常状态。

注意：1. 有可能存在被完全放电后，不推荐再一次进行充电的锂离子可充电电池。这是由于锂离子可充电电池的特性而决定的，所以当决定允许或禁止向0 V电池充电时，请向电池厂商确认详细情况。

2. 对于充电过电流检测功能来说，向0 V电池充电更具优先权。因此，允许向0 V电池充电的产品，在电池电压比VOD还低时会被强制地充电，而不能进行充电过电流的检测工作。

This function is used to recharge a connected battery whose voltage is 0 V due to self-discharge. When the 0 V battery charge starting charger voltage (V_{0CHA}) or a higher voltage is applied between the P+ and P- pins by connecting a charger, the charge control MOSFET gate is fixed to the VDD pin voltage. When the voltage between the gate and source of the charge control MOSFET becomes equal to or higher than the threshold voltage due to the charger voltage, the charge control MOSFET is turned on to start charging. At this time, the discharge control MOSFET is off and the charging current flows through the internal parasitic diode in the discharge control MOSFET. When the battery voltage becomes equal to or higher than V_{OD}, the chip returns to the normal status.

Note: 1. Some battery providers do not recommend charging for a completely self-discharged lithium-ion rechargeable battery. Please ask the battery provider to determine whether to enable or inhibit the 0 V battery charge function.

2. The 0 V battery charge function has higher priority than the charge overcurrent detection function. Consequently, a product in which use of the 0 V battery charge function is enabled charges a battery forcibly and the charge overcurrent cannot be detected when the battery voltage is lower than V_{OD}.

■ 典型应用原理图 / Application Circuits

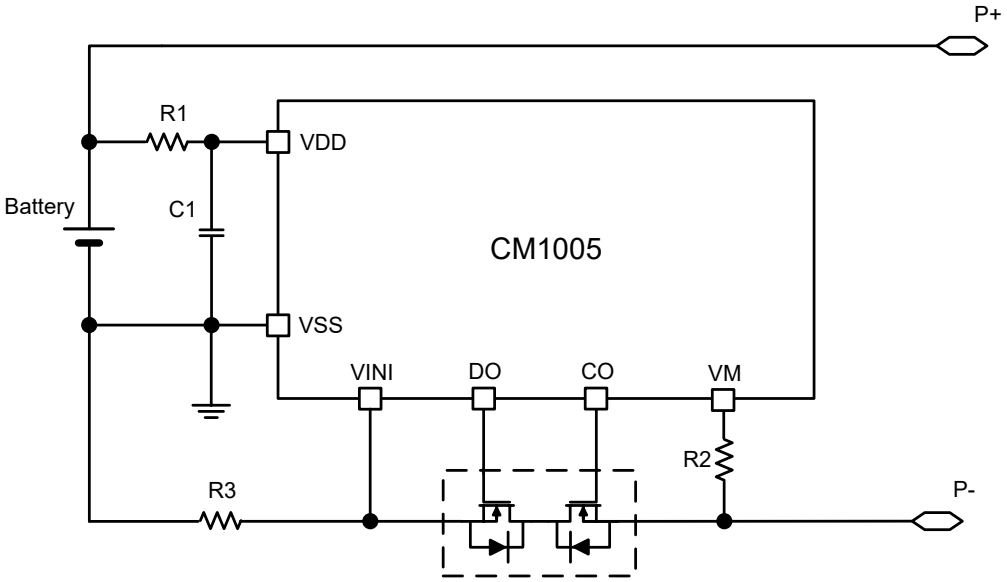


Figure 5

器件标识 Component Symbol	典型值 Type	参数范围 Range	单位 Unit
R1	330	270 ~ 1500	Ω
C1	0.1	0.068 ~ 2.200	μF
R2	1.0	0.3 ~ 3.0	kΩ
R3	1.5	-	mΩ

Table 9

注意：

1. 上述参数有可能不经预告而作更改。

2. 上述IC的原理图以及参数并不作为保证电路工作的依据，请在实际的应用电路上进行充分的实测后再设定参数。

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.

■ 时序图 / Operation Timing Chart

1. 过充电保护、充电过流保护 / Overcharge and Charging Overcurrent Detection

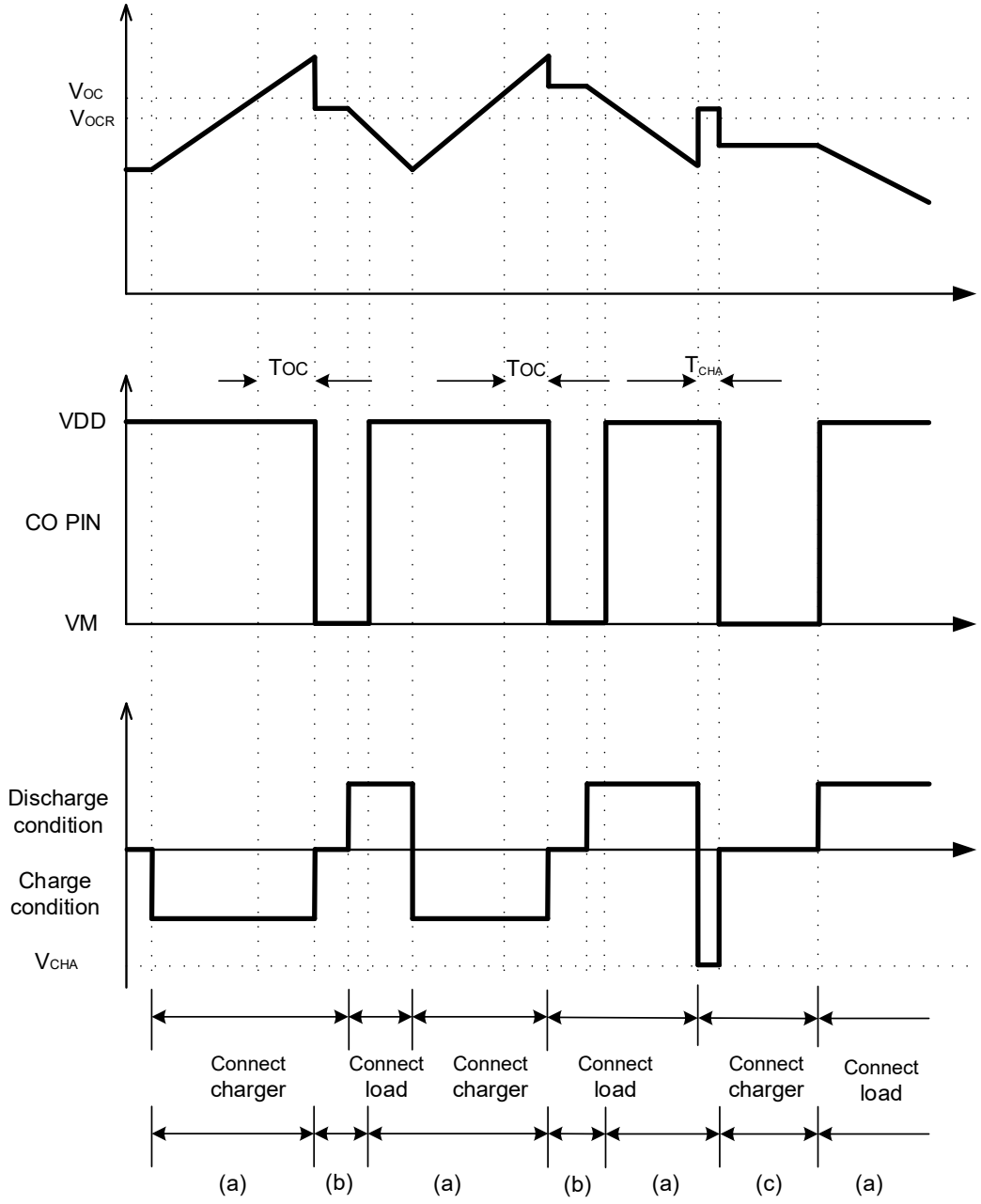


Figure 6

(a) 正常工作状态 / Normal condition

(b) 过充电状态 / Overcharge condition

(c) 充电过流状态 / Charging overcurrent condition

2. 过放电保护、放电过流保护 / Over discharge and discharging Overcurrent Condition Detection

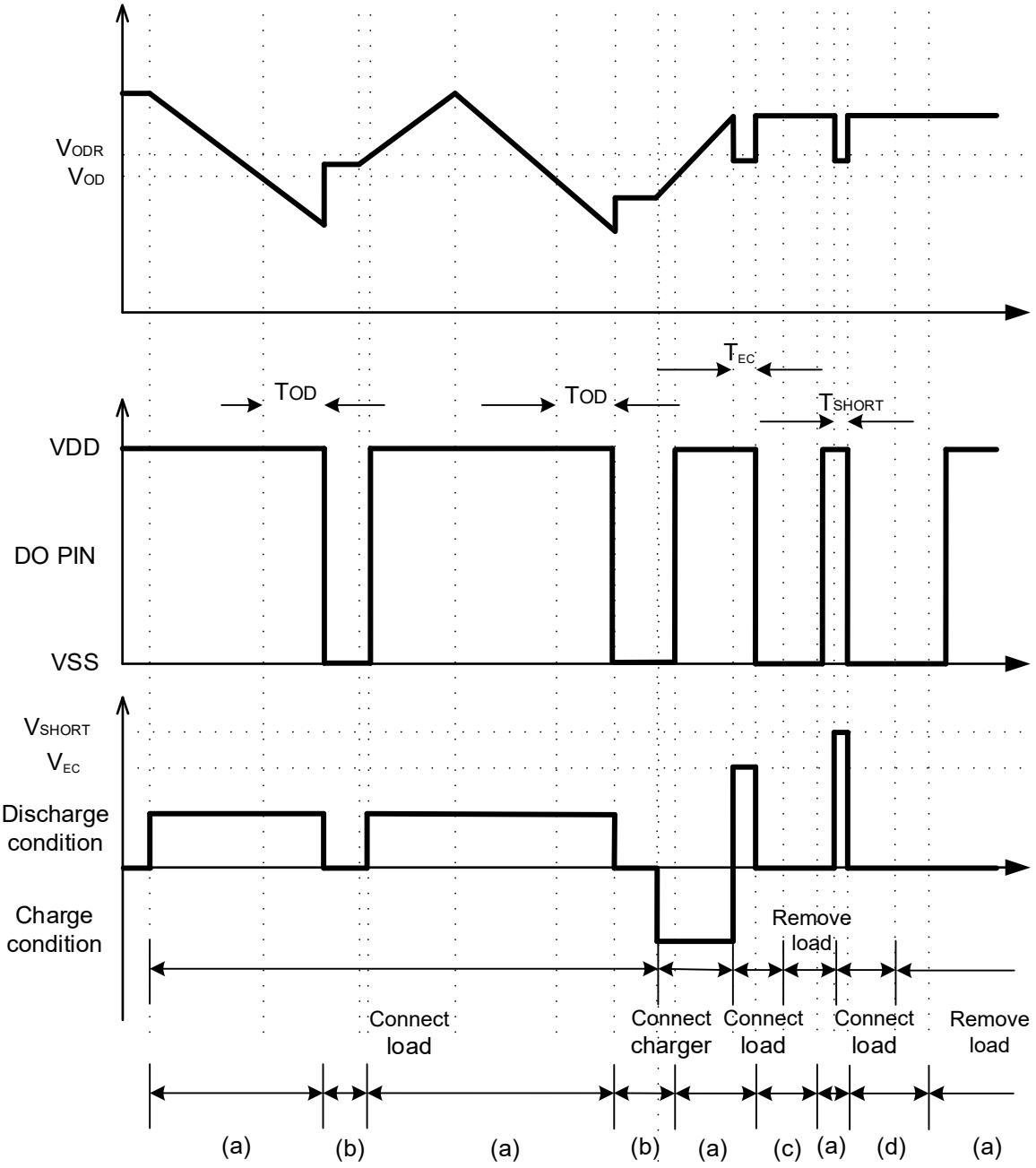


Figure 7

(a) 正常工作状态 / Normal condition

(b) 过放电状态 / Over discharge condition

(c) 放电过流状态 / Discharging overcurrent condition

(d) 负载短路状态 / Load short circuit

■ 测试电路 / Test Circuits

1. **过充电保护电压、过充电解除电压（测试电路 1） / Overcharge protection voltage, Overcharge release voltage（Test Circuits 1）**

在V1=3.5V设置后的状态下，将V1缓慢提升至V_{CO}="H" → "L" 时的V1的电压即为过充电保护电压 (V_{OC})。之后，将V1缓慢下降至V_{CO}="L" → "H" 时的V1的电压即为过充电解除电压 (V_{OCR})。

Overcharge detection voltage (V_{OC}) is defined as the voltage V1 at which V_{CO} goes from "H" to "L" when the voltage V1 is gradually increased after setting V1 = 3.5 V. Overcharge release voltage (V_{OCR}) is defined as the voltage V1 at which V_{CO} goes from "L" to "H" when the voltage V1 is then gradually decreased.

2. **过放电保护电压、过放电解除电压（测试电路 2） / Over discharge protection voltage, Over discharge release voltage（Test Circuits 2）**

在V1=3.5V, V2=V5=0V设置后的状态下，将V1缓慢降低至V_{DO}="H" → "L" 时的V1的电压即为过放电保护电压(V_{OD})。之后，设置V2=0.3V，将V1缓慢提升至V_{DO}="L" → "H" 时的V1的电压即为过放电解除电压 (V_{ODR})。

Overdischarge detection voltage (V_{OD}) is defined as the voltage V1 at which V_{DO} goes from "H" to "L" when the voltage V1 is gradually decreased after setting V1 = 3.5 V, V2 = V5 = 0 V. Overdischarge release voltage (V_{ODR}) is defined as the voltage V1 at which V_{DO} goes from "L" to "H" when setting V2 = 0.3 V, and when the voltage V1 is then gradually increased.

3. **放电过电流保护电压、放电过电流解除电压（测试电路 5） / Discharge overcurrent protects voltage 1, Discharge overcurrent release voltage（Test Circuits 5）**

在V1=3.5V、V2=1.0V、V5=0V设置后的状态下，将V5提升，从电压提升后开始到V_{DO}="H" → "L" 为止的延迟时间即为放电过电流检测延迟时间 (T_{EC})，此时的V5的电压即为放电过电流检测电压 (V_{EC})。之后，设置V2=3.5V、V5=0V，将V2缓慢降低至V_{DO}="L" → "H" 时的V2的电压即为放电过电流解除电压 (V_{RIOV})。当V2的电压降低到V_{RIOV}之下时，经过1.0ms (典型值) 后V_{DO}变为"H"，并在负载短路检测延迟时间 (T_{SHORT}) 内持续保持"H"。

Discharge overcurrent detection voltage (V_{EC}) is defined as the voltage V5 whose delay time for changing V_{DO} from "H" to "L" is discharge overcurrent detection delay time (T_{EC}) when the voltage V5 is increased after setting V1 = 3.5 V, V2 = 1.0 V, V5 = 0 V. Discharge overcurrent release voltage (V_{RIOV}) is defined as the voltage V2 at which V_{DO} goes from "L" to "H" when setting V2 = 3.5 V, V5 = 0 V and when the voltage V2 is then gradually decreased. When the voltage V2 falls below V_{RIOV}, V_{DO} will go to "H" after 1.0 ms typ. and maintain "H" during load short- circuiting detection delay time (T_{SHORT}).

4. **负载短路保护电压 1（测试电路 2） / Load short-circuit protection voltage 1（Test Circuits 2）**

在V1=3.5V、V2=1.0V、V5=0V设置后的状态下，将V5提升，从电压提升后开始到V_{DO}="H" → "L" 为止的延迟时间即为T_{SHORT}，此时V5的电压即为负载短路检测电压1(V_{SHORT1})。

Load short-circuiting detection voltage 1 (V_{SHORT1}) is defined as the voltage V5 whose delay time for changing V_{DO} from "H" to "L" is T_{SHORT} when the voltage V5 is increased after setting V1 = 3.5 V, V2 = 1.0 V, V5 = 0 V.

5. **负载短路检测电压 2 (测定电路 2) / Load short-circuit protection voltage 2（Test Circuits 2）**

在V1=3.5V、V2=V5=0V设置后的状态下，将V2提升，从电压提升后开始到VDO="H" → "L" 为止的延迟时间即为T_{SHORT}，此时的V2的电压即为负载短路检测电压2(V_{SHORT2})。

Load short-circuiting detection voltage 2 (V_{SHORT2}) is defined as the voltage V2 whose delay time for changing V_{DO} from "H" to "L" is T_{SHORT} when the voltage V2 is increased after setting V1 = 3.5 V, V2 = V5 = 0 V.

6. **充电过流保护电压（测试电路 2） / Charge overcurrent protection voltage（Test Circuits 2）**

在V1=3.5V、V2=V5=0V设置后的状态下，将V5降低，从电压降低后开始到V_{CO}="H" → "L" 为止的延迟时间即为充电过电流检测延迟时间(T_{CHA})，此时的V5的电压即为充电过电流检测电压(V_{CHA})。

Charge overcurrent detection voltage (V_{CHA}) is defined as the voltage V5 whose delay time for changing V_{CO} from "H" to "L" is charge overcurrent detection delay time (T_{CHA}) when the voltage V5 is decreased after setting V1 = 3.5 V, V2 = V5 = 0 V.

7. **工作时消耗电流（测试电路 3） / Operating consumption current（Test Circuits 3）**

在 V1=3.5V, V2=V5=0V 设置后的状态下，流经 VDD 端子的电流(I_{CC})即为工作时消耗电流(I_{OPE})。

When V1=3.5V and V2 = V5 = 0 V are set, the current I_{CC} flowing through the VDD pin is the current consumed while working (I_{OPE}).

8. **过放电时消耗电流（测试电路 3） / Overdischarge consumption current（Test Circuits 3）**

在 V1=V2=1.2V, V5=0 V 设置后的状态下，I_{DD} 即为过放时消耗电流 (I_{OPED})。

When V1=V2=1.2V and V5 = 0 V are set, the current I_{CC} flowing through the VDD pin is the current consumed while overdischage (I_{OPED}).

9. **VDD 端子-VM 端子间电阻（测试电路 3） / Resistance between VDD pin and VM pin（Test Circuits 3）**

在 V1=1.8V, V2=V5=0 V 设置后的状态下，VDD 端子–VM 端子间电阻即为 R_{VMD}。

When V1=1.8V and V2=V5=0V are set, the resistance between VDD pin and VM pin is R_{VMD}.

10. **VM 端子-VSS 端子间电阻（测试电路 3） / Resistance between VM pin and VSS pin（Test Circuits 3）**

在 V1=3.5V, V2=V5=1.0V 设置后的状态下，将 V5 降低至 0 V 时的 VM 端子–VSS 端子间电阻即为 R_{VMS}。

When V1=3.5V and V2=V5=1.0V are set, the resistance between VM pin and VSS pin is R_{VMS} when V5 is decreased to 0 V.

11. **CO 端子电阻“H”（测试电路 4） / CO pin resistance "H"（Test Circuits 4）**

在 V1=3.5V, V2=V5=0V, V3=3.0V 设置后的状态下，VDD 端子–CO 端子间电阻即为 CO 端子电阻 "H" (R_{COH})。

When V1=3.5V, V2=V5=0V, and V3=3.0V are set, the resistance between VDD pin and CO pin is the CO pin resistance "H" (R_{COH}).

12. **CO 端子电阻“L”（测试电路 4） / CO pin resistance "L"（Test Circuits 4）**

在 V1=4.7V, V2=V5=0V, V3=0.4V 设置后的状态下，VM 端子–CO 端子间电阻即为 CO 端子电阻 "L" (R_{COL})。

When V1=4.7V, V2=V5=0V, and V3=0.4V are set, the resistance between VM pin and CO pin is the CO pin resistance "L" (R_{COL}).

13. **DO 端子电阻“H”（测试电路 4） / DO pin resistance "H"（Test Circuits 4）**

在 V1=3.5V, V2=V5=0V, V4=3.0V 设置后的状态下，VDD 端子–DO 端子间电阻即为 DO 端子电阻 "H" (R_{DOH})。

When V1=3.5V, V2=V5=0V, and V4=3.0V are set, the resistance between VDD pin and DO pin is the DO pin resistance "H" (R_{DOH}).

14. **DO 端子电阻“L”（测试电路 4） / DO pin resistance "L"（Test Circuits 4）**

在 V1=1.8V, V2=V5=0V, V4=0.4V 设置后的状态下，VSS 端子–DO 端子间电阻即为 DO 端子电阻 "L" (R_{DOL})。

When V1=1.8V, V2=V5=0V, and V4=0.4V are set, the resistance between VSS pin and DO pin is the DO pin resistance "L" (R_{DOL}).

15. **过充电保护延迟时间（测试电路 5） / Overcharge detection delay time（Test Circuits 5）**

在V1=3.5V, V2=V5=0V设置后的状态下，将V1提升，从V1超过V_{OC}时开始到V_{CO}="L" 为止的时间即为过充电保护延迟时间 (T_{OC})。

When V1=3.5V and V2=V5=0V are set, V1 is pulled up and the time from V1 exceeding V_{OC} to V_{CO} = "L" is the overcharge protection delay time (T_{OC}).

16. **过放电保护延迟时间（测试电路 5） / Over discharge detection delay time（Test Circuits 5）**

在V1=3.5 V, V2=V5=0V设置后的状态下，将V1降低，从V1低于V_{OD}时开始到V_{DO}="L" 为止的时间即为过放电保护延迟时间

(T_{OD})。

When V1=3.5V and V2=V5=0V are set, V1 is lowered and the time from V1 exceeding V_{OD} to V_{DO} = "L" is the over discharge protection delay time (T_{OD}).

17. **放电过流保护延迟时间（测试电路 5） / Discharge overcurrent detection delay time 1（Test Circuits 5）**

在V1=3.5V, V2=1.0V, V5=0V设置后的状态下，将V5提升，从V5超过V_{EC}时开始到V_{DO}="L" 为止的时间即为放电过流保护延迟时间 (T_{EC})。

When V1=3.5V, V2=1.0V and V5=0V are set, V5 is pulled up and the time from V5 exceeding V_{EC} to V_{DO} = "L" is the discharge overcurrent protection delay time (T_{EC}).

18. **负载短路保护延迟时间（测试电路 5） / Load short-circuiting detection delay time（Test Circuits 5）**

在V1=3.5 V、V2=1.0V、V5=0 V设置后的状态下，将V5提升，从V5超过V_{SHORT1}时开始到V_{DO}="L" 为止的时间即为负载短路保护延迟时间 (T_{SHORT})。

When V1=3.5V, V2=1.0V and V5=0V are set, V5 is pulled up and the time from V5 exceeding V_{SHORT1} to V_{DO} = "L" is the Load short-circuiting detection delay time (T_{SHORT}).

19. **充电过流保护延迟时间（测试电路 5） / Charge overcurrent detection delay time（Test Circuits 5）**

在V1=3.5V, V2=V5=0V设置后的状态下，将V5降低，从V5低于V_{CHA}时开始到V_{CO}="L" 为止的时间即为充电过流保护延迟时间 (T_{CHA})。

When V1=3.5V and V2=V5=0V are set, V5 is lowered and the time from V5 is lower than V_{CHA} to V_{CO} = "L" is the charge overcurrent protection delay time (T_{CHA}).

20. **开始向 0V 电池充电的充电器电压("允许"向 0V 电池充电的功能)（测试电路 4） / The charger voltage for starting 0V battery charging (0V battery charge function "Enabled") (Test Circuits 4)**

在V1=V5=0V, V2=V3=−0.5 V设置后的状态下，将V2缓慢降低，流经CO端子的电流 (I_{CO}) 超过1.0μA时的V2的电压的绝对值即为开始向0 V电池充电的充电器电压(V_{0CHA})。

The 0 V battery charge starting charger voltage (V_{0CHA}) is defined as the absolute value of voltage V2 at which the current flowing through the CO pin (I_{CO}) exceeds 1.0 μA when the voltage V2 is gradually decreased after setting V1 = V5 = 0 V, V2 = V3 = −0.5 V.

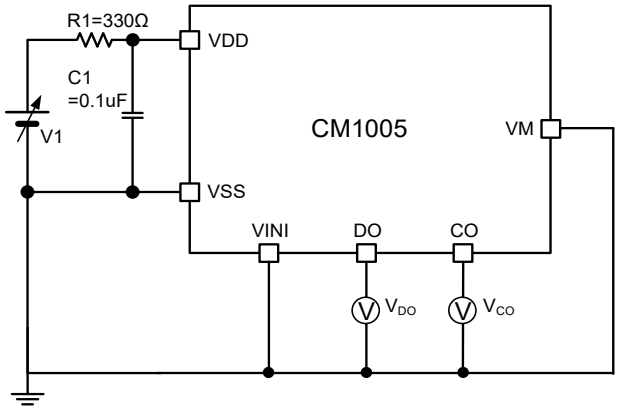


Figure 8 Test Circuits 1

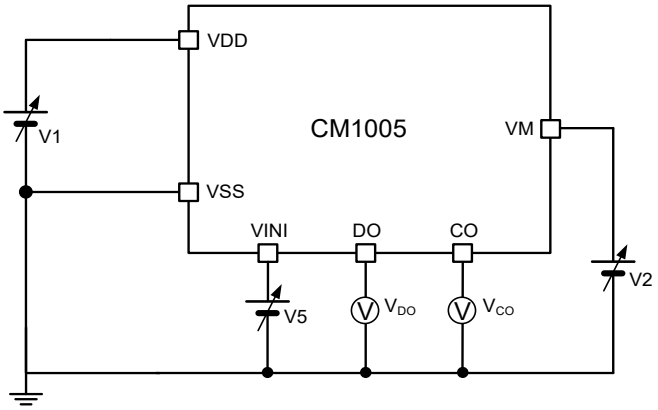


Figure 9 Test Circuits 2

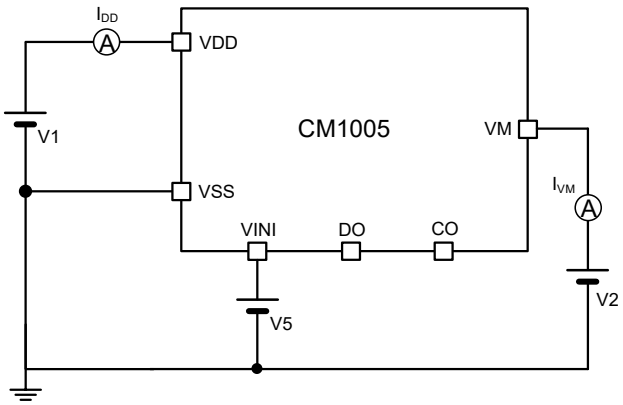


Figure 10 Test Circuits 3

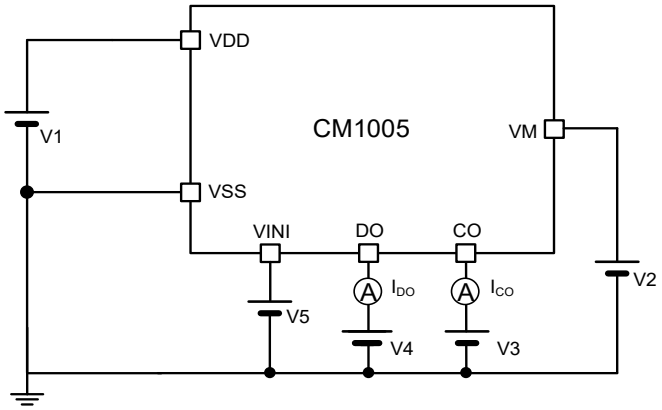


Figure 11 Test Circuits 4

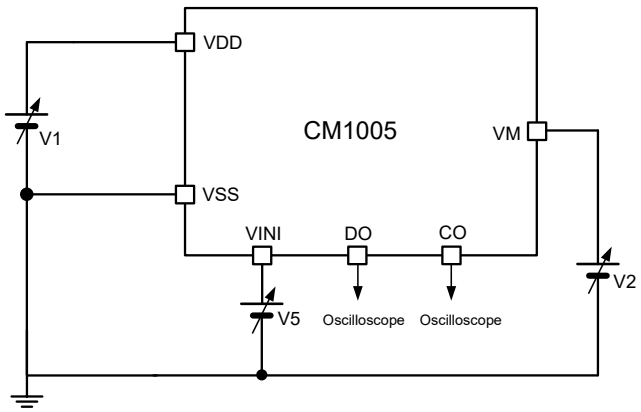


Figure 12 Test Circuits 5

■ 封装信息 / Package

DFN1.9×1.6-6L

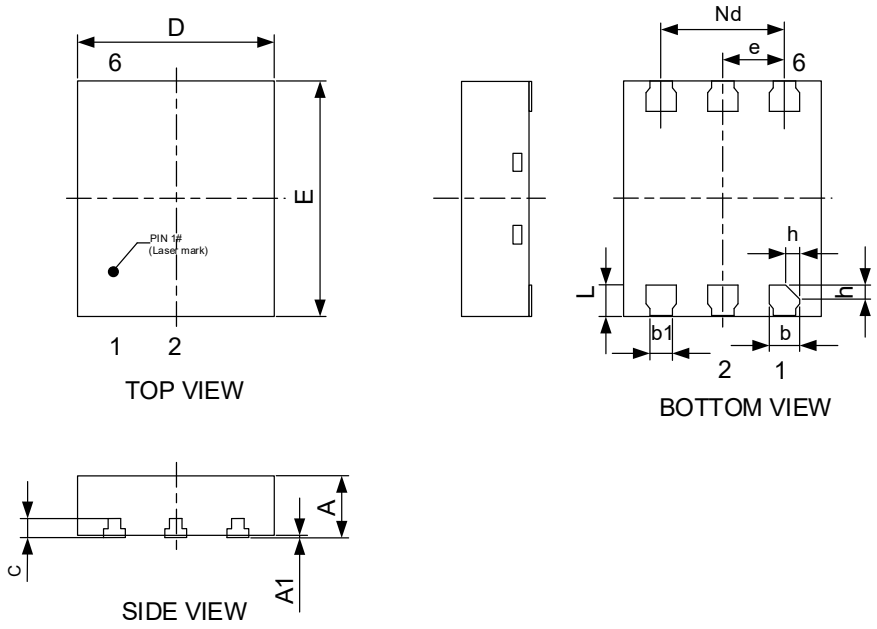


Figure 13

NOTE: ALL DIMENSIONS IN MM

SYMBOL	MIN	NOM	MAX
A	0.40	0.50	0.60
A1	0	0.02	0.05
b	0.20	0.25	0.30
b1		0.18REF	
c		0.152REF	
D	1.50	1.60	1.70
e		0.50BSC	
Nd		1.00BSC	
E	1.80	1.90	2.00
L	0.20	0.25	0.30
h	0.07	0.12	0.17

Table 10

■ PCB 尺寸推荐 / PCB Layout Recommendations

DFN1.9×1.6-6L

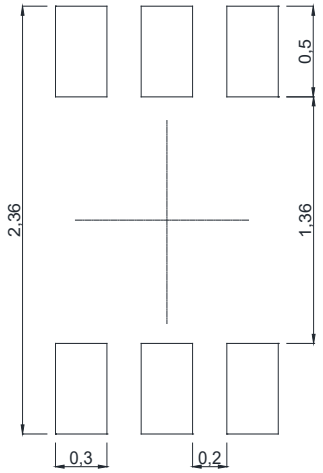


Figure 14

注意：1.请勿在塑封体下印刷丝网、焊锡，避免产品被顶起。

2.钢网的开口尺寸和开口位置请与焊盘对齐。

3.请向引脚的前端方向扩展焊盘模式。

4.请勿向封装中间的范围内扩大焊盘模式。

Notes:

1. **Do not apply solder paste or solder under the molding compound to prevent the component from being lifted.**
2. **Align the stencil aperture sizes and positions with the solder pads.**
3. **Extend the pad pattern in the outward direction of the pins.**
4. **Do not extend the pad pattern into the center area of the package.**

■ 载带信息 / Carrier Tape information

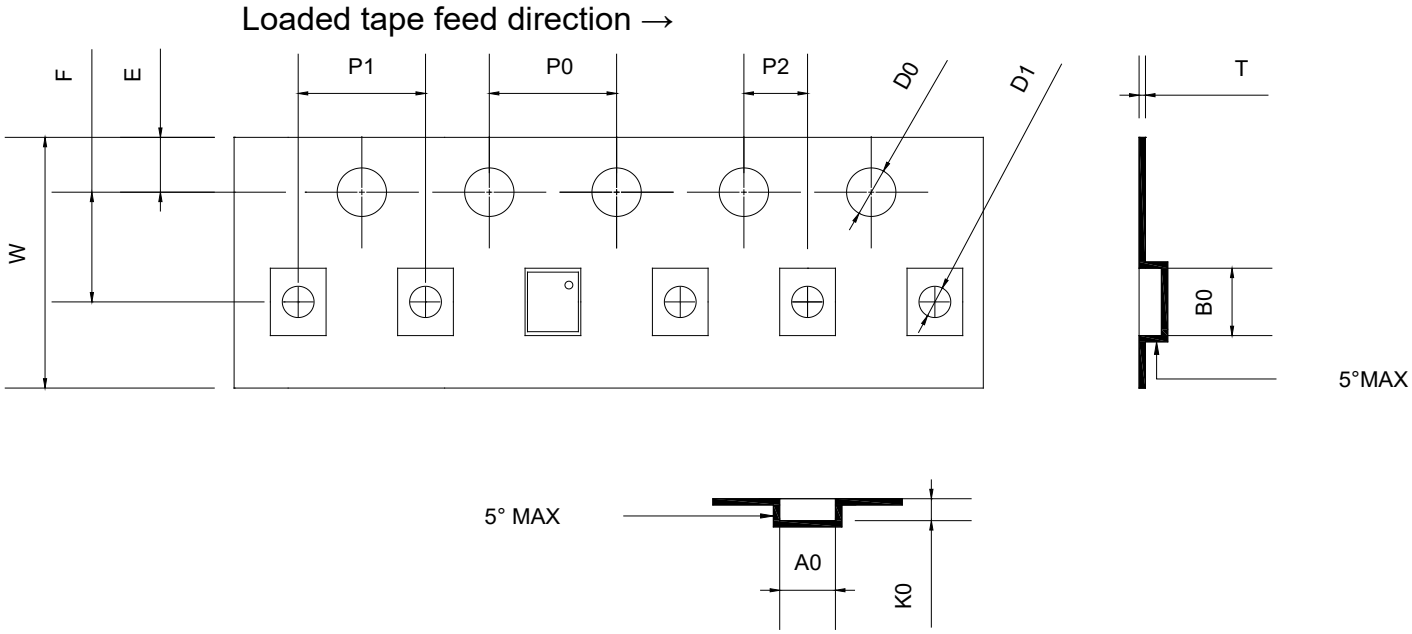


Figure 15

Type	W*P1	Unit
DFN1.9*1.6	8.0*4.0	mm
Item	**Specification**	**Tol（+/-）**
W	8.00	±0.20
F	3.50	±0.05
E	1.75	±0.10
P2	2.00	±0.05
P1	4.00	±0.10
P0	4.00	±0.10
P0*10	40.00	±0.20
D0	1.50	+0.10/-0
D1	1.00	±0.10
T	0.20	±0.02
B0	2.15	±0.10
A0	1.75	±0.10
K0	0.75	±0.10

Table 11

■ 卷盘信息 / Reel information

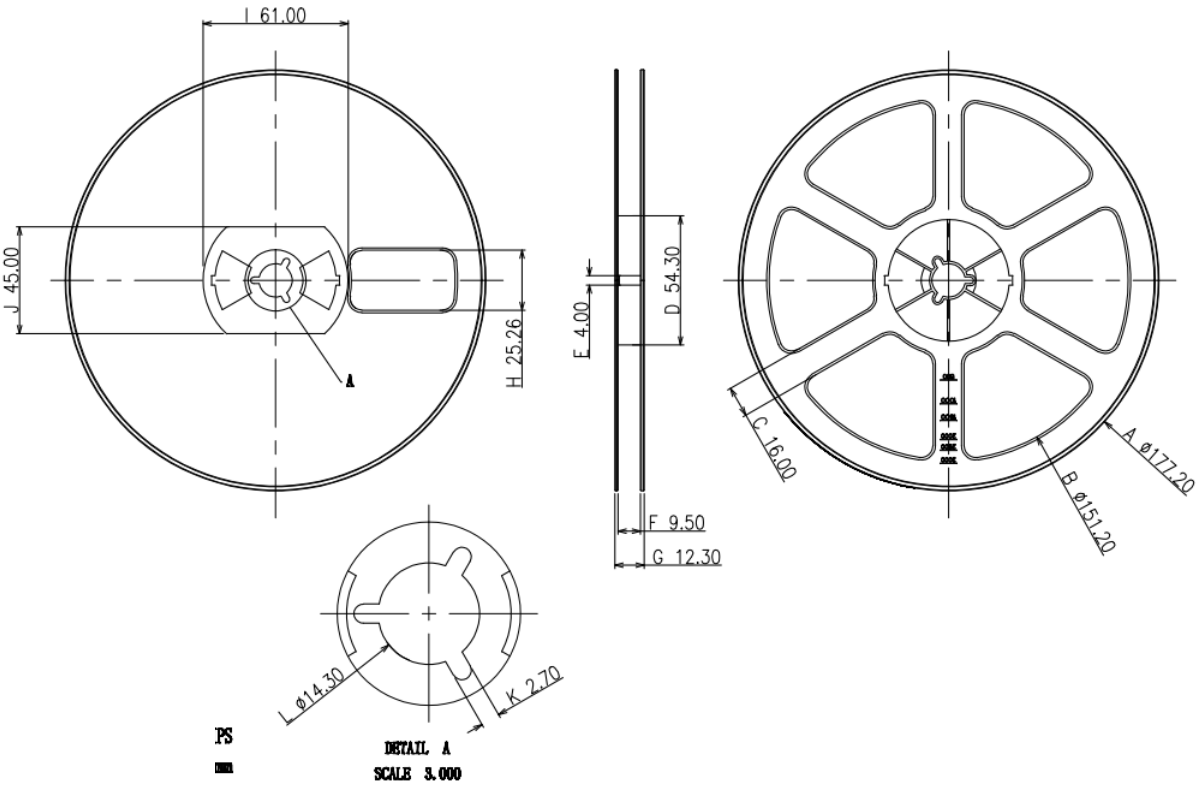


Figure 16

■ 包装信息 / Package information

卷盘 Reel	颗/盘 PCS/Reel	盘/盒 Reel /Inner Box	盒/箱 Inner Box/Carton
7”	3000 PCS	10	4

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