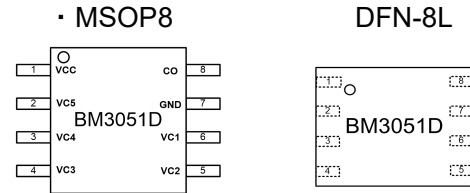# BM3051D Series

2~5 Cells Secondary Protection IC

Features /产品特点

⑴ High-accuracy voltage detection：
高精度电压检测功能：
- Overcharge threshold
  过充电检测电压
  3.6 V ~ 4.6 V
- Accuracy:
  精度
  ±25 mV（+25℃）
  ±30 mV（-5℃ ~ 55℃）
- overcharge hysteresis：
  过充电滞后电压
  50mV; 100mV; 200mV; 360mV selectable
  50mV；100mV；200mV；360mV 可选

⑵ Delay time input selectable:
保护延时内置可选：
1s ~ 4s，1s step
1s ~ 4s, 1s 步进

⑶ CO output mode:
CO 输出方式
CMOS output, active "H";
CMOS 输出，动态高

⑷ Open wire protection
断线保护功能

⑸ Wide operation voltage: 5 ~ 28V
宽工作电压：5 ~ 28V

⑹ Wide operation temperature range:-40℃ ~ 85℃;
宽工作温度范围：-40℃ ~ 85℃；

⑺ Low power consumption:
低功耗：
- Operation mode 2.0 uA （+25℃）
  工作时 2.0 uA (+25℃)
- Sleeping mode 1.5 uA （+25℃）
  休眠时 1.5 uA (+25℃)

⑻ Pb free (Sn 100%), halogen free
无铅（Sn 100%）、无卤素

Package /封装形式

· MSOP8   DFN-8L

General description /产品概述

The BM3051D is a secondary protection IC for rechargeable battery pack, it is highly integrated, high accuracy, and low power consumption. By monitor each cell's voltage, IC provide protection when the batteries are changing. If any of V1, V2 V3, V4 and V5 is higher than V_{OVP} and lasts longer than T_{OVP}, the output voltage of CO will become high level from low level, the control MOSFET will be open and the fuse will be browned.

BM3051D 系列产品是一款高精度、高集成度、低功耗的可充电电池二级保护芯片。通过检测电池包中每一节电芯的电压，为电池包提供过充电保护。当任意一节电芯电压达到过充阈值，芯片经过过充保护延时 T_{OVP} 后，使得 CO 输出变成高电平，控制 MOS 管开启，将熔丝熔断。
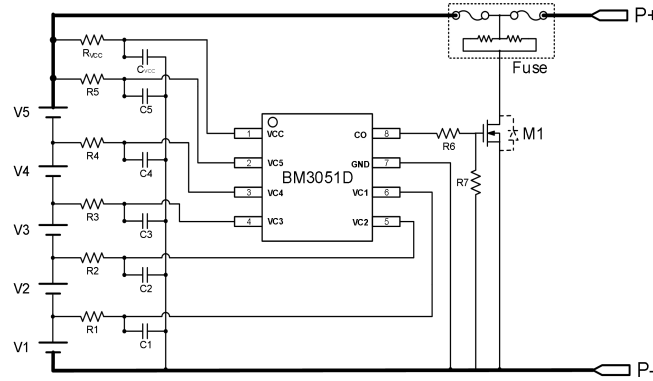
Applications /应用领域

· Power tool /电动工具
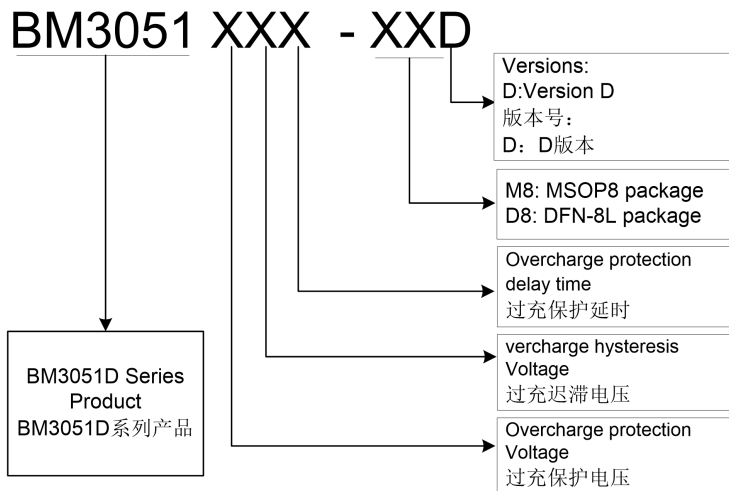· Notebook /笔记本电脑
· UPS backup battery /后备电源
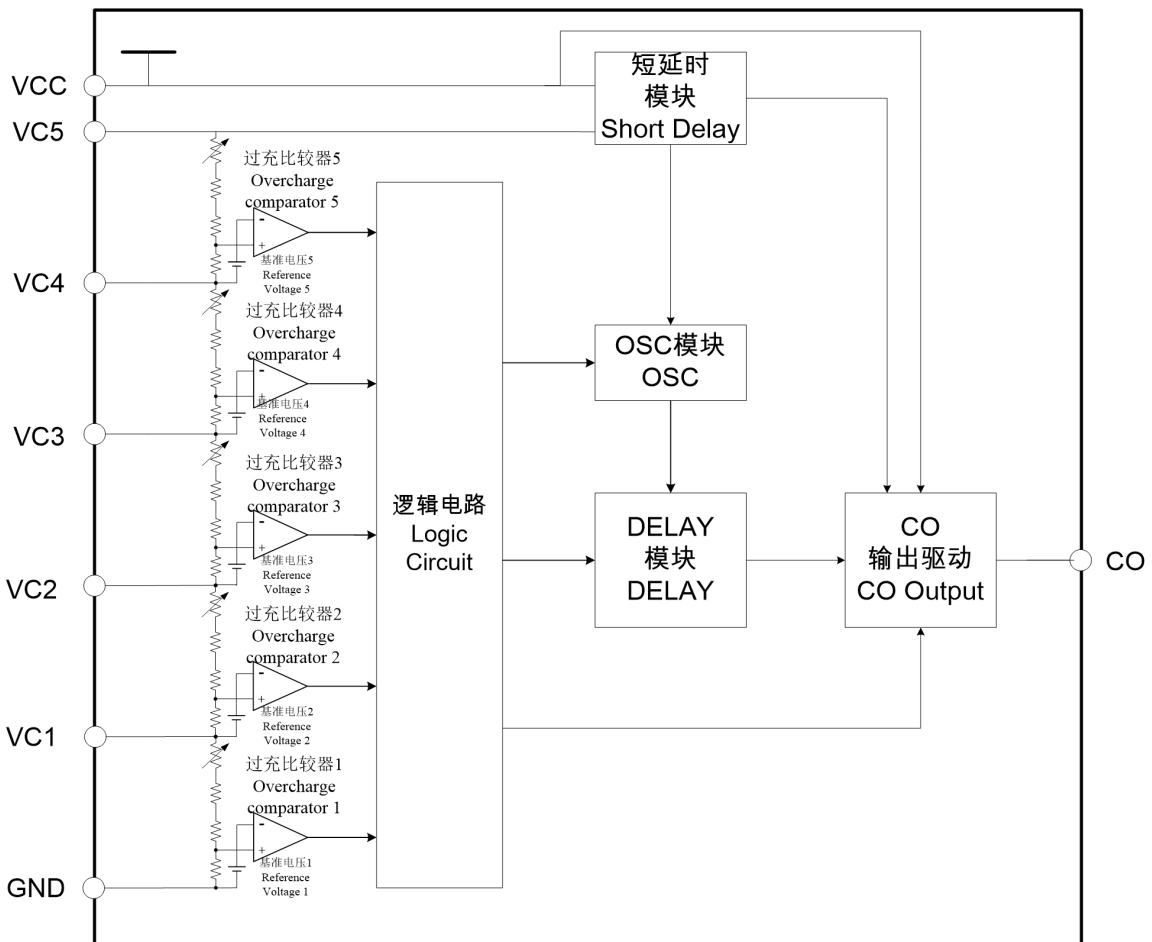
Typical application circuit /典型应用电路

Product catalogue /产品选型

Type/Item 型号/项目	Overcharge protection Voltage (V_{OVP}) 过充保护电压(V_{OVP})	Overcharge hysteresis Voltage (V_{HYS}) 过充迟滞电压(V_{HYS})	Overcharge protection delay time (T_{OVP}) 过充保护延时(T_{OVP})	Output mode 输出方式	Output logic 输出逻辑	Package 封装形式
BM3051FAA-M8D	4.220V	0.050V	1s	CMOS	Active"H"	MSOP8
BM3051JBA-M8D	4.225V	0.100V	1s	CMOS	Active"H"	MSOP8
BM3051KBA-M8D	4.250V	0.100V	1s	CMOS	Active"H"	MSOP8
BM3051NCB-M8D	4.300V	0.200V	2s	CMOS	Active"H"	MSOP8
BM3051OCD-M8D	4.350V	0.200V	4s	CMOS	Active"H"	MSOP8
BM3051HAA-M8D	4.200V	0.050V	1s	CMOS	Active"H"	MSOP8
BM3051LAB-M8D	4.275V	0.050V	2s	CMOS	Active"H"	MSOP8

Products name structure /产品命名规则

BM3051 XXX - XXD

Versions:
D:Version D
版本号：
D：D版本

M8: MSOP8 package
D8: DFN-8L package

Overcharge protection
delay time
过充保护延时

vercharge hysteresis
Voltage
过充迟滞电压

Overcharge protection
Voltage
过充保护电压

BM3051D Series
Product
BM3051D系列产品

Block Diagram /功能框图

Pin Configurations /引脚排布

MSOP8

Top View

DFN-8L

Top View
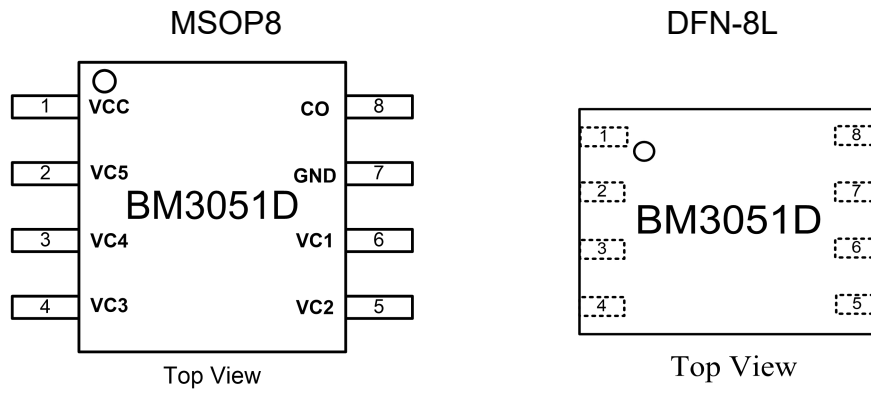
Pin number 引脚号	name 名称	Description 描述
1	VCC	IC power supply 芯片供电端子
2	VC5	Cell5 positive input 电池 5 的正电压连接端子
3	VC4	Cell4 positive input, Cell5 negative input 电池 4 的正电压、电池 5 的负电压连接端子
4	VC3	Cell3 positive input, Cell4 negative input 电池 3 的正电压、电池 4 的负电压连接端子
5	VC2	Cell2 positive input, Cell3 negative input 电池 2 的正电压、电池 3 的负电压连接端子
6	VC1	Cell1 positive input, Cell2 negative input 电池 1 的正电压、电池 2 的负电压连接端子
7	GND	Ground pin of the IC, Cell1 negative input 芯片的地、电池 1 的负电压连接端子
8	CO	Charge MOS gate control pin 充电端控制，MOS 栅极连接端子

Absolute Maximum Ratings /绝对最大额定值

Item 项目	Symbol 符号	Description 适用端子	Ratings 绝对最大额定值	Unit 单位
Power supply voltage 电源电压	VCC	-	GND-0.3 ~ GND+30	V
Single cell input voltage 各节电池电压	VC_N	VC5、VC4、VC3、VC2、VC1	GND-0.3 ~ GND+6	V
CO output voltage CO 输出端子电压	V_{CO}	CO	GND-20 ~ VCC+0.3	V
Operating temperature 工作环境温度	T_A	-	-40 ~ +85	℃
Storage temperature 贮存温度	T_{STG}	-	-40 ~ +125	℃
HBM 人体模型静电放电	V_{ESD}	-	2000	V

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.

注意：绝对最大额定值是指无论在任何条件下都不能超过的额定值。一旦超过此额定值，有可能造成产品劣化等物理性损伤。

Electrical Characteristics /电气特性

（T_A=25℃ unless otherwise specified）　　（除特殊说明外：T_A=25℃）

Item 项　目		Symbol 符号	Test conditions*1 测试条件*1	Min. 最小值	Typ. 典型值	Max. 最大值	Unit 单位	*2
Power supply voltage 电源电压		VCC	-	5	-	28	V	1
VCC input current VCC 流入电流		I_{VCC}	V1=V2=V3=V4=V5=3.5V	-	0.8	1.2	uA	
VC5 input current VC5 流入电流		I_{VC5}	V1=V2=V3=V4=V5=3.5V		1.2	1.8	uA	
VC_n input current (n=1,2,3,4) VC_n 流入电流(n=1,2,3,4)		I_{VCn}	V1=V2=V3=V4=V5=3.5V	-0.3	0	0.3	uA	
Overcharge 过充电	Protection threshold 保护阈值	V_{OVP}	V1=V2=V3=3.5V V4=3.5→4.4V	V_{OVP}-0.025	V_{OVP}	V_{OVP}+0.025	V	2

	Protection delay time 保护延时	T_{OVP}	V1=V2=V3=3.5V V4=3.5V→4.4V	0.7* T_{OVP}	T_{OVP}	1.3* T_{OVP}	s	
	Hysteresis voltage 迟滞电压	V_{HYS}	V1=V2=V3=V4=3.5V V5=4.4→3.5V, V_{HYS} is 50mV	V_{HYS} -0.025	V_{HYS}	V_{HYS} +0.025	V	
		V_{HYS}	V1=V2=V3=V4=3.5V V5=4.4→3.5V, V_{HYS}>50mV	V_{HYS} -0.050	V_{HYS}	V_{HYS} +0.050	V	
	Release delay time 解除延时	T_{REL1}	V1=V2=V3=3.5V V4=4.4V→3.5V	10	20	30	ms	
	Temperature factor 温度系数	K_U	Ta= -40℃ to 85℃	-0.6	0	0.6	mV/℃	
Test mode time 测试模式 时间	Test mode 测试模式	T_M	V1=V2=V3=V4=3.5V V5=3.5V→4.4V	5	10	15	ms	3
	Test mode protection delay time 测试模式 保护延时	T_{TP}	V1=V2=V3=V4=3.5V V5=3.5V→4.4V	1	2	4	ms	
CO CMOS output current CO 为 CMOS 输出电流	CO input current CO 吸收电流	I_{COL}	Normal state，CO "L"(0) 正常态, CO "L"(0)	0.3	-	-	mA	4
	CO output current CO 输出电流	I_{COH}	Protection state, CO "H" (VDD) 保护态, CO "H" (VDD)	50	-	-	uA	

*1：All the test condition parameters above are designed based on Li+ parameters, other grade parameters can adjust by their own actual voltages.

以上测试条件均以锂电参数参考设计，其他档位参数根据实际电压调整。

*2：The test circuit symbols.

测试电路图的记号。

Function Description /工作说明

1. Normal State /通常状态

When the voltage of each cell is lower than V_{REL}, the output voltage of CO is "L", call this state as normal state.

各节电池的电压处于过充电恢复电压 V_{REL} 之下，CO 端子的输出为低电平"L"。这种状态称为通常状态。

2. Overcharge State /过充电状态

During charging, if any of V1, V2, V3, V4 and V5 is higher than V_{OVP} and lasts longer than T_{OVP}, the output voltage of CO will become "H" from "L". And through control the external FET, achieve charging control and the secondary protection.

电池在充电时，只要 V1、V2、V3、V4、V5 中任意一节电压值高于 V_{OVP} 并持续了一段时间 T_{OVP}，CO 端子开始翻转，由低电平变为高电平，这种状态称为过充电状态。CO 端子通过外连接 FET，即可进行充

电控制以及二级保护。

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

All cells' voltage is less than the overcharge release threshold (V_{HYS}) and stays a period of time (T_{REL}).

满足下面条件即可解除过充电状态：

所有电芯的电压都低于 V_{HYS} 并持续 T_{REL}。

3. Test Mode /测试模式

For quickly test convenience to customers, when the voltage of VCC pin is 5V higher than VC5 and last longer than T_M, BM3051D can turn to test mode to shorten delay time of overcharge protection (T_{OVP}). Under this test mode, overcharge protection delay time of each cell will shorten to T_{TP}.

Change the voltage of VCC pin to VC5, the test mode will be released and the chip returns to normal delay mode.

为了方便用户快速测试，可通过转换为测试模式缩短过充电检测延迟时间（T_{OVP}）。当 VCC 端子电压比 VC5 端子电压高出 5.0V 以上，且这种状态持续超过测试模式判断延时 T_M 时，芯片转换为测试模式。
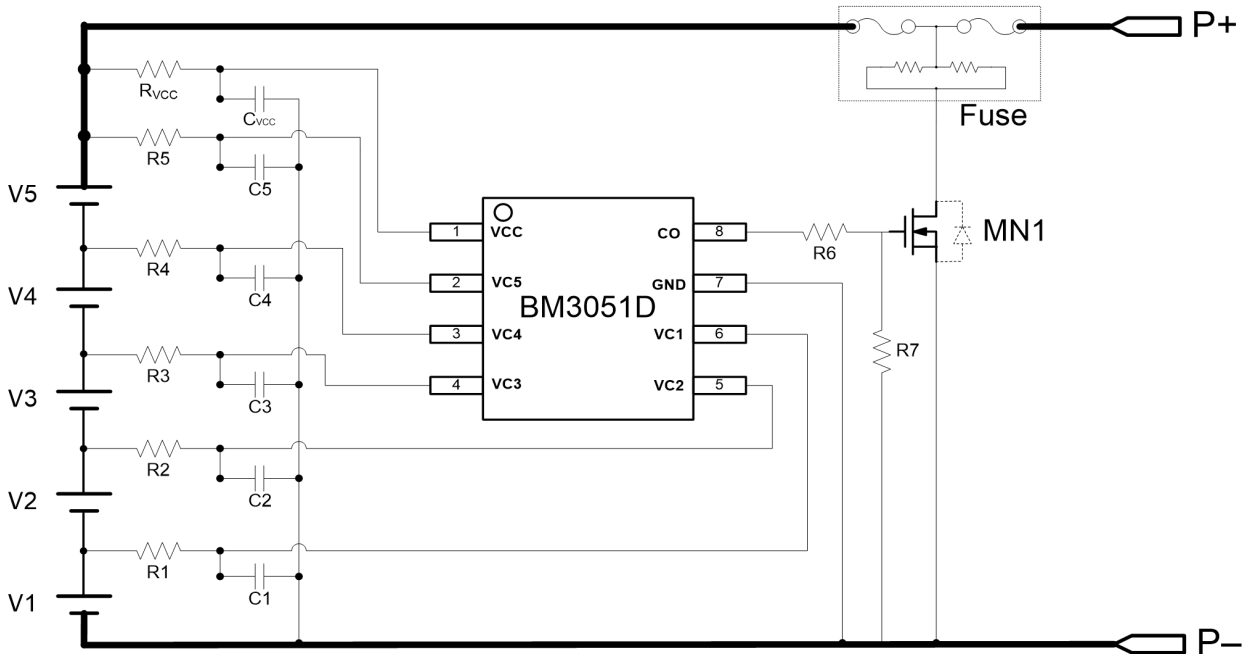
在测试模式下，各节电芯的过充保护延时将缩短为 T_{TP}。

只要将 VCC 端子电压恢复至和 VC5 端子电压相同即可解除测试模式，恢复为正常保护延时模式。
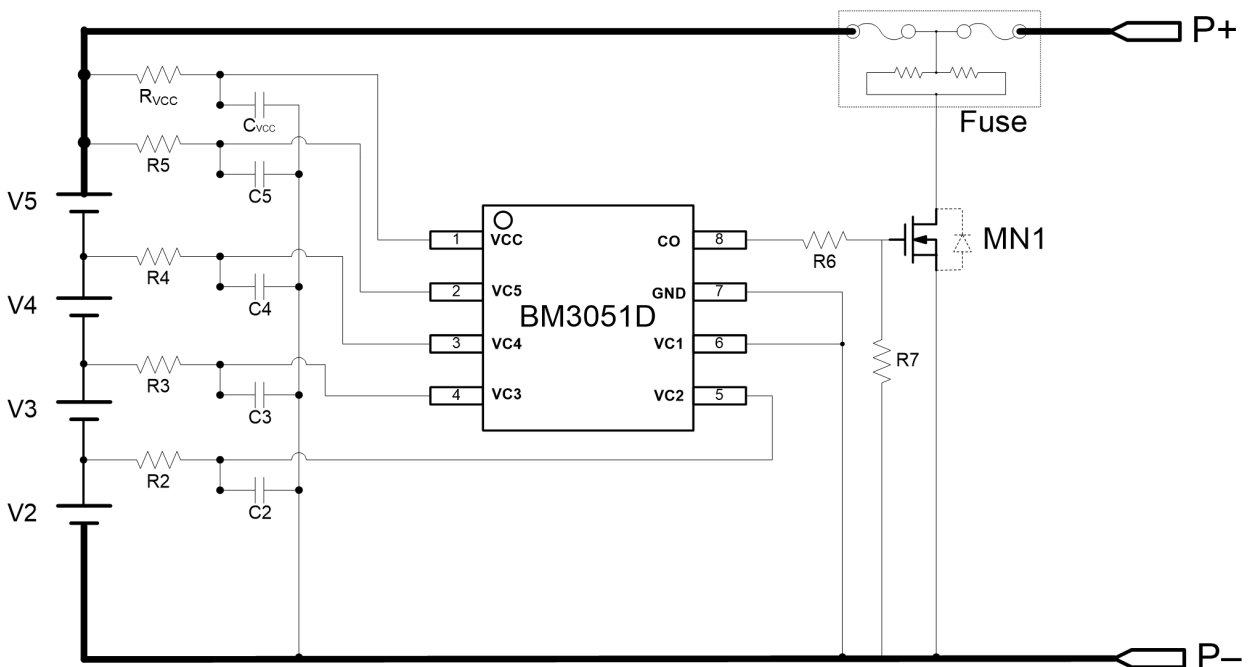
Operation Timing Charts /工作时序图
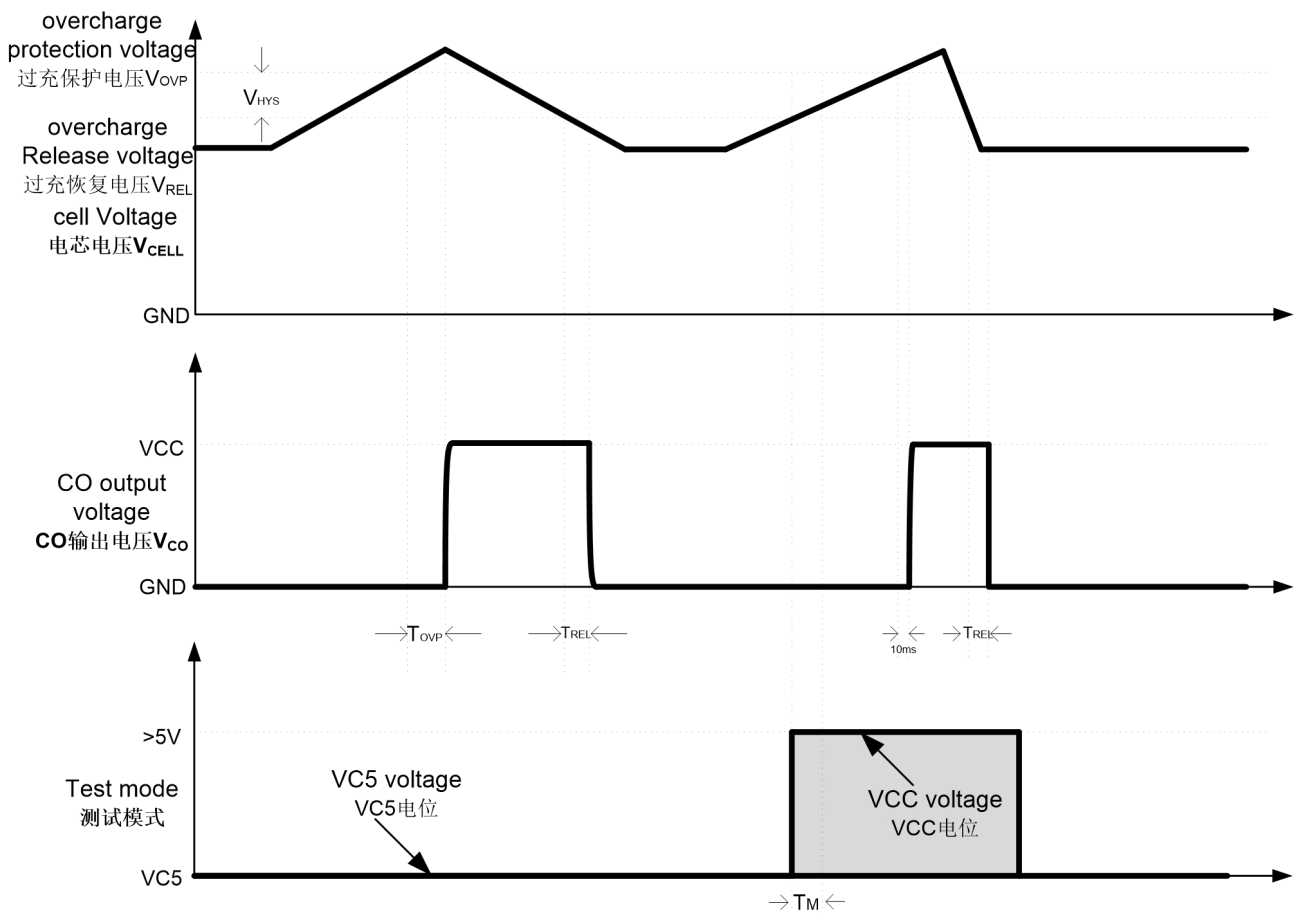
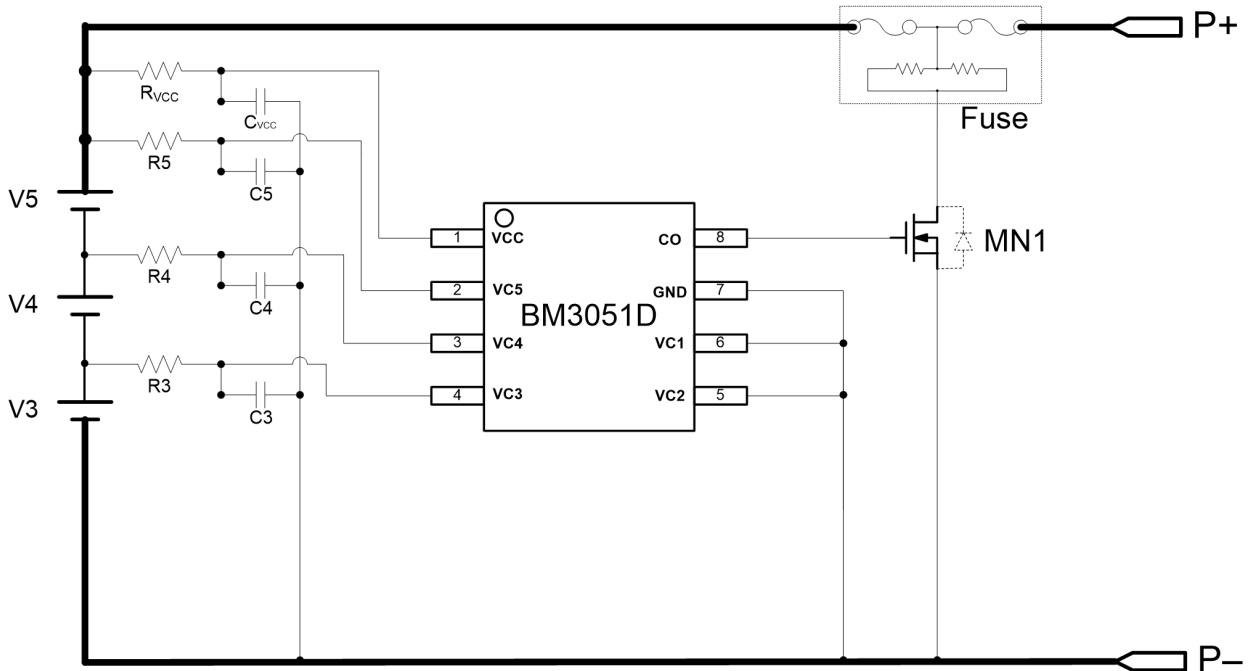## Application Circuits /应用电路

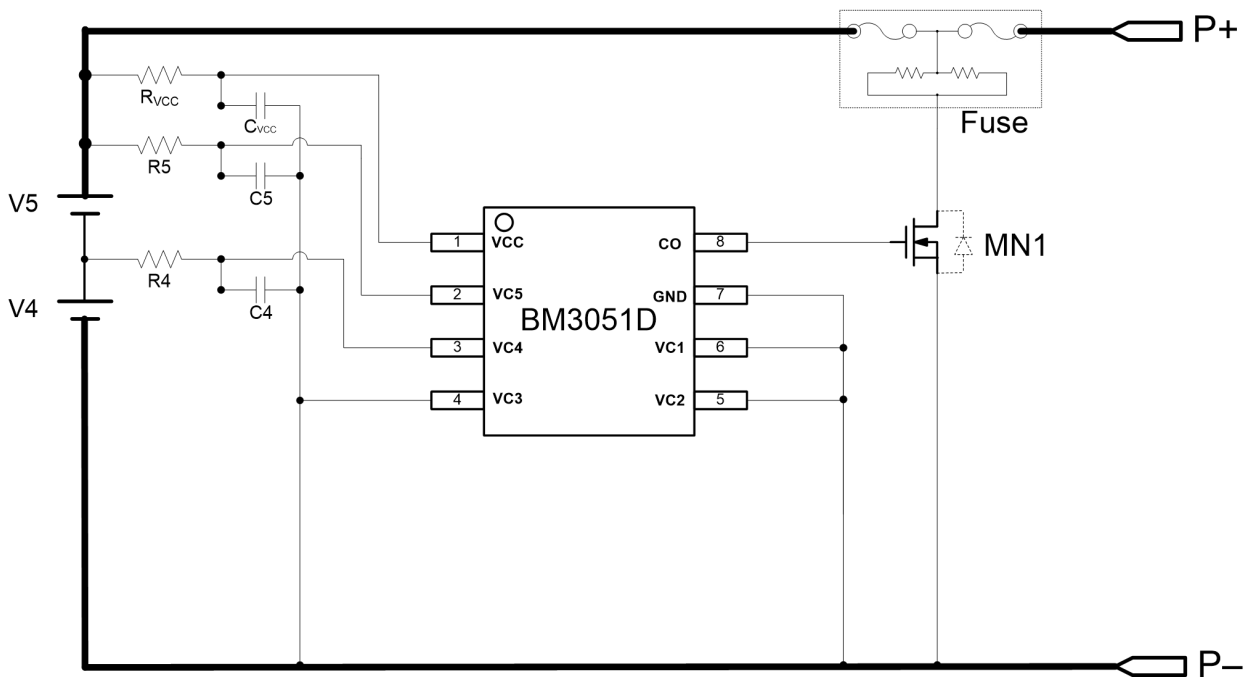（1）Fuse connected on P+ /熔丝在 P+端：

5-cell application

5 串应用

4-cell application

4 串应用

3-cell application

3 串应用

2-cell application

2 串应用

（2）NMOS connected on P- /直接控制回路 NMOS：
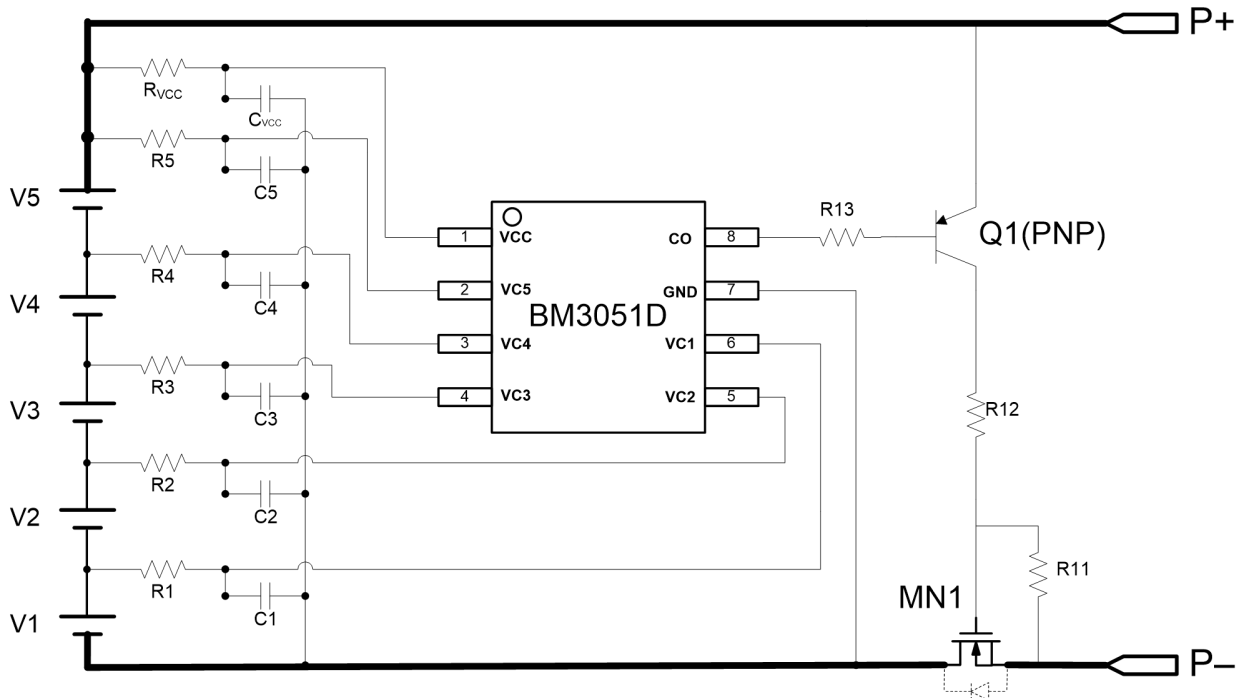
5-cell NMOS control circuit application
5 串控制回路 NMOS 应用

Constants for External Components:

电阻、电容推荐值如下：

Component Symbol 器件标号	Typ. 典型值	Range 范围		Unit 单位
R_{VCC}	1	0.33 ~ 2		KΩ
R1、R2、R3、R4、R5	1	0.33 ~ 2		KΩ
R6、R7	3.3	-		MΩ
R11、R13	4.7	-		MΩ
R12	1.0	-		MΩ
C_{VCC}	2.2	0.1~4.7	Maximum endurable voltage >25V	uF
C1、C2、C3、C4、C5	0.1	0.1~1.0		uF

Test circuit /测试电路

1. Normal and Sleeping Current Consumption /正常功耗及休眠功耗

Test circuit 1 /测试电路 1

⑴ Set V1 = V2 = V3 = V4 = V5 = 3.5V, monitor the current of A1 and A2, the summation of A1 and A2 ($I_1 + I_2$) is the normal operating current consumption.

设定 V1 = V2 = V3 = V4 = V5 = 3.5V，观察电流表 A1 和 A2 的读数，两个电流之和（$I_1 + I_2$）即为正常功耗。

⑵ Base on the (1), set V1 = V2 = V3 = V4 = V5 = 2.0V, monitor the current of A1 and A2, the summation of A1 and A2 ($I_1 + I_2$) is the sleeping operating current consumption.

在⑴的基础上，设定 V1 = V2 = V3 = V4 = V5 = 2.0V，观察电流表 A1 和 A2 的读数，两个电流之和（$I_1 + I_2$）即为休眠功耗。

2. Overcharge Test /过充电测试

2.1 Overcharge protection threshold (V_{OVP}) and Overcharge release threshold (V_{REL})
过充电保护及保护解除阈值

Test circuit 2 /测试电路 2

Set V1 = V2 = V3 = V4 = V5 = 3.50V, make sure the output voltages of CO pins are "L" level. Increase V5 gradually, monitor CO voltage and keep the condition not shorter than overcharge protection delay time, the value of V5 when CO turns from "L" to "H" is the overcharge threshold voltage (V_{OVP}). Decrease V5, the V5 when CO returns to "L" level again is the overcharge release threshold (V_{REL}).

设定 V1 = V2 = V3 = V4 = V5 = 3.5V，确保 CO 为"L"。逐渐增大任意一节电池电压，维持时间不小于过充电保护延时，以 V5 为例，当 CO 由"L"变"H"时的 V5 电压即为过充电保护阈值电压（V_{OVP}）；逐渐减小 V5，维持时间不小于过充电保护解除延时，当 CO 重新变为"L"时，V5 电压即为过充电保护解除阈值电压（V_{REL}）。

2.2 Overcharge protection delay time and Overcharge release delay time
过充电保护及过充电回复延时

Test circuit 2 /测试电路 2

⑴ Set V1 = V2 = V3 = V4 = V5 = 3.50V, make sure the output voltages of CO pins are "L" level. Increase V5 to 4.5V from 3.5V instantaneously, monitor CO voltage and keep a period of time. The time interval when CO turns from "L" to "H" is the overcharge protection delay time.

设定 V1 = V2 = V3 = V4 = V5 = 3.5V，确保 CO 为"L"。将 V5 骤升至 4.5V，监控 CO 电压并维持一段时间，CO 由"L"变"H"的时间间隔即为过充电延时。

⑵ Set V1 = V2 = V3 = V4 = V5 = 3.50V, V5 = 4.5V, make sure the output voltage of CO is "H" level. Decrease V5 to 3.5V from 4.5V instantaneously, monitor CO voltage and keep a period of time. The time interval when the output voltage of CO turns from "H" to "L" is the overcharge release delay time.

设定 V1 = V2 = V3 = V4 = 3.5V，V5 = 4.5V，确保 CO 为"H"。将 V5 骤降至 3.5V，监控 CO 电压并维持一段时间，CO 由"H"变"L"的时间间隔即为过充电回复延时。

2.3 Overcharge protection delay time and Overcharge release delay time under test mode
测试模式下的过充电保护及过充电回复延时

Test circuit 3 测试电路 3

⑴ Set V1 = V2 = V3 = V4 = V5 = 3.5V, V6 = 5V, make sure the output voltage of CO is "L" level.

Increase V5 to 4.5V from 3.5V instantaneously，monitor CO voltage and keep a period of time，the time interval when CO turns from "L" to "H" is the overcharge protection delay time.

设定 V1 = V2 = V3 = V4 = V5 = 3.5V，V6 = 5V，确保 CO 为"L"。将 V5 骤升至 4.5V，监控 CO 电压并维持一段时间，CO 由"L"变"H"的时间间隔即为过充电延时。

⑵ Set V1 = V2 = V3 = V4 = 3.5V, V5 = 4.5V, V6 = 5V, make sure the output voltage of CO is "H" level. Decrease V5 to 3.5V from 4.4V instantaneously, monitor CO voltage and keep a period of time. The time interval when the output voltage of CO turns from "H" to "L" is the overcharge release delay time.

设定 V1 = V2 = V3 = V4 = 3.5V，V5 = 4.5V，V6 = 5V，确保 CO 为"H"。将 V5 骤降至 3.5V，监控 CO 电压并维持一段时间，CO 由"H"变"L"的时间间隔即为过充电回复延时。

3. CO Output/Input Resistance Test   /CO 输入/输出电阻测试

(1) The output resistances when the output voltage of CO is "L"

CO 为低电平时的输出电阻

Test circuit 4 /测试电路 4

Set V1 = V2 = V3 = V4 = V5 = 3.5V, V6 = 0.00V, turn off the switch K and make sure the output voltage of CO pin is "L". Turn on the switch K, increase the voltage V6 gradually from 0V, monitor the value of I_A, note down the output voltage V_{CO} of DO pin when the value of I_A is 50uA, then the output resistance of CO is calculated as follows: $R_{COL} = V_{CO}/50$ (MΩ).

设定 V1 = V2 = V3 = V4 = V5 = 3.5V，V6 = 0.00V，断开开关 K，确保此时 CO 输出为"L"，测量 CO 端的电压为 0V；闭合开关 K，V6 从 0V 开始上升，监测电流表的读数为 I_A，当 I_A=-50uA 时测得 CO 端的电压 V_{CO}，则 CO 输出电阻 R_{COL} = $V_{CO}/50$ (MΩ)。

(2) The output resistance when the output voltage of CO pin is "H".

CO 为高电平时的输出电阻

Test circuit 4 测试电路 4

Set V1 = V2 = V3 = V4 = V5 = 4.50V, V6 = 22.5V, turn off the switch K and make sure the output voltage of CO pin is "H". Measure the voltage of CO pin is 22.5V; turn on the switch K, decrease the voltage V6 gradually from 22.5V, monitor the value of I_A, and note down the output voltage V_{CO} of CO pin when the value of I_A is 50uA, then the output resistance of CO is calculated as follows: $R_{COH}=(22.5-V_{CO})/50$(MΩ).
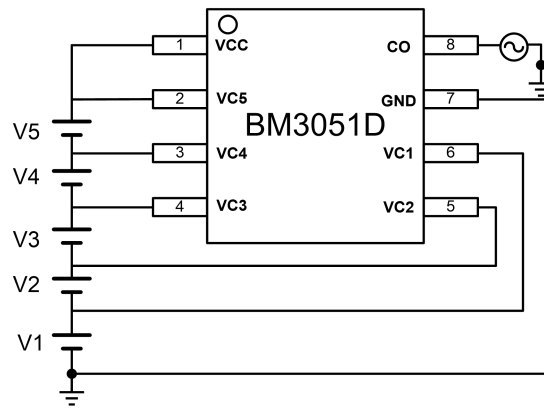
设定 V1 = V2 = V3 = V4 = V5 = 4.5V，V6 = 22.5V，断开开关 K，确保此时 CO 输出为"H"用电压表测试 CO 端电压为 22.5V；将开关 K 闭合，调节 V6 从 22.5V 开始降低，同时监测电流表的读数为 I_A，当 I_A = 50uA 时测得 CO 电位为 V_{CO}，则 CO 输出电阻 R_{COH} = $(22.5-V_{CO})/50$ (MΩ)。
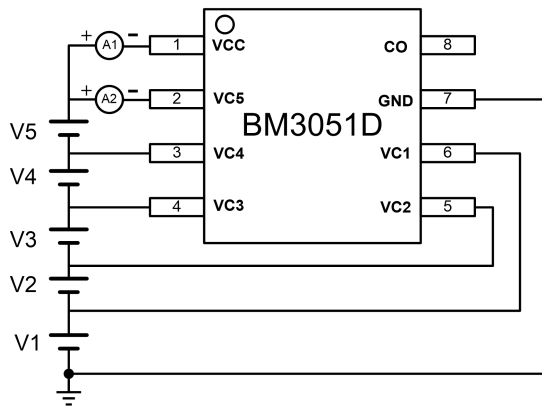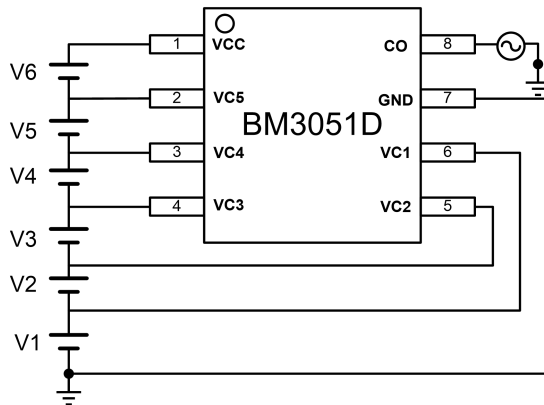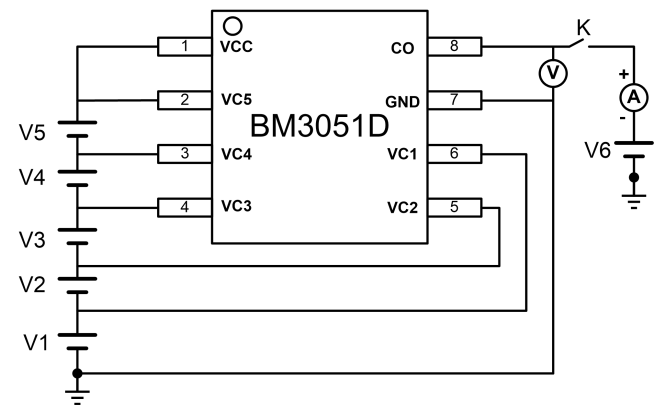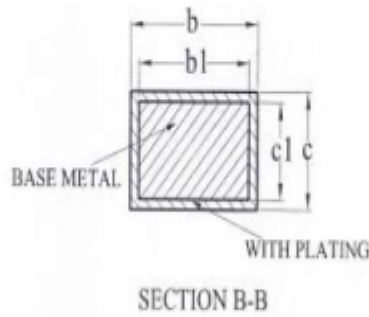
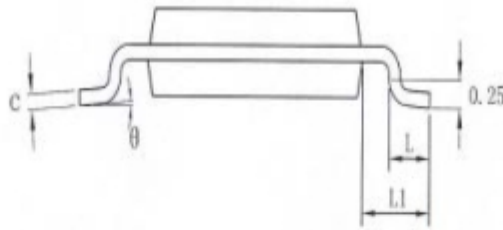Test Circuit 1

测试电路 1

Test Circuit 2
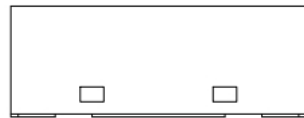
测试电路 2

Test Circuit 3

测试电路 3

Test Circuit 4

测试电路 4

Package Information /封装示意图及参数

MSOP8
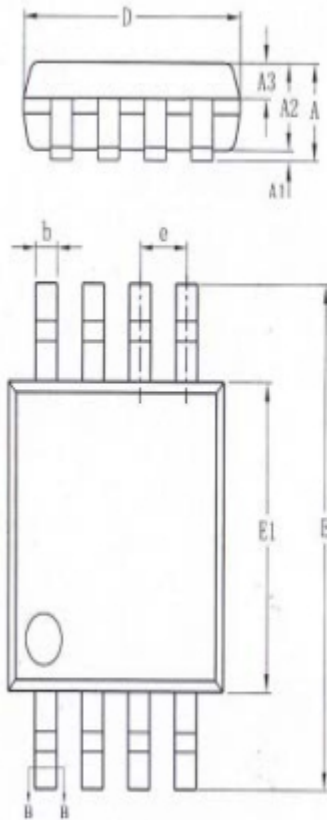
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.10
A1	0.05	—	0.15
A2	0.75	0.85	0.95
A3	0.30	0.35	0.40
b	0.28	—	0.36
b1	0.27	0.30	0.33
c	0.15	—	0.19
c1	0.14	0.15	0.16
D	2.90	3.00	3.10
E	4.70	4.90	5.10
E1	2.90	3.00	3.10
e	0.65BSC		
L	0.40	—	0.70
L1	0.95REF		
θ	0	—	8°

BASE METAL

WITH PLATING

SECTION B-B

DFN2*2-8L

TOP VIEW   SIDE VIEW   BOTTOM VIEW
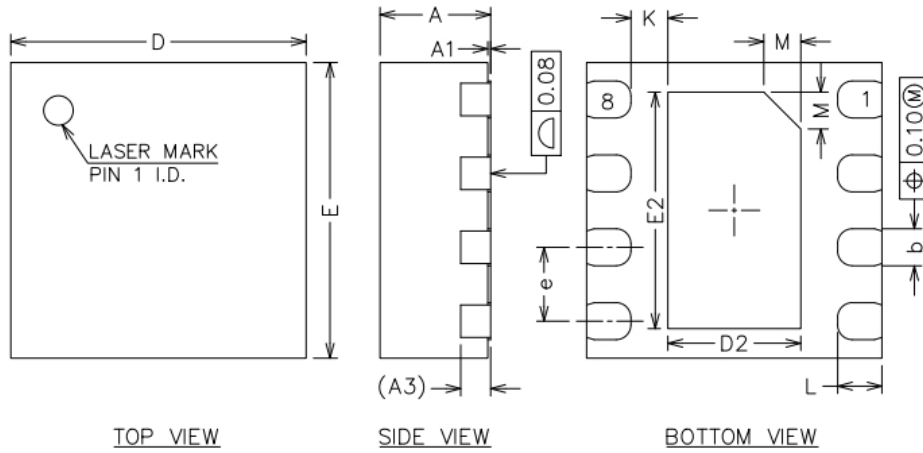
SIDE VIEW

COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3	0.203REF		
b	0.20	0.25	0.30
D	1.90	2.00	2.10
E	1.90	2.00	2.10
D2	0.80	0.90	1.00
E2	1.50	1.60	1.70
e	0.40	0.50	0.60
K	0.15	0.25	0.35
L	0.25	0.30	0.35
M	0.25REF		

Packing /包装：

MSOP8：MBB packing.13"reel，4000pcs per reel.

DFN-8L：MBB packing.7"reel，3000pcs per reel.

MSOP8 封装形式：13 寸的 MBB 静电袋，每盘装 4000 颗。

DFN-8L 封装形式：7 寸的 MBB 静电袋，每盘装 3000 颗。

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