

LiFePO4 battery 2-CELL Protector HM5425

General Description

HM5425 Series IC are a 2-cell LiFePO4 battery protection battery protector, built-in high precision voltage detection circuit and delay circuit, suitable for 2-cell series of rechargeable LiFePO4 battery overcharge, overdischarge and overcurrent protection; The chip working voltage is 1.5 V to 10 V ,connect the charger terminal resistance to high pressure design (absolute maximum rating 33 V),0 V battery charging function is optional,5.0 uA low static current in normal working conditions, the power flow is less than 0.1 uA in sleeping conditions.

Features

(1) High accuracy detection voltage

●Overcharge detection voltage V_{CU_n} ($n=1, 2$)	3.60V~4.00V	precision $\pm 25\text{mV}$
●Overcharge release voltage V_{CR_n} ($n=1, 2$)	3.40V~3.80V	precision $\pm 50\text{mV}$
●Overdischarge detection voltage V_{DL_n} ($n=1, 2$)	1.80V~2.20V	precision $\pm 80\text{mV}$
●Overdischarge release voltage V_{DR_n} ($n=1, 2$)	1.80V~2.50V	precision $\pm 100\text{mV}$
●Overcurrent detection voltage of discharge	0.10V~0.35V	precision $\pm 30\text{mV}$
●Overcurrent detection voltage of charge	- 0.31V~-0.11V	precision $\pm 30\text{mV}$
●Short Circuit detection voltage	1.0V (fixed)	precision $\pm 0.4\text{V}$

(2) Internal fixed output delay time (not need external capacitors)

●Overcharge detection output Delay	typical values 1000ms
●Overdischarge detection output Delay	typical values 110ms
●Overcurrent detection of discharge output Delay	typical values 10ms
●Overcurrent detection of charge output Delay	typical values 7ms
●Short Circuit detection output delay	typical values 250μs

(3) Low current consumption

● At working conditions	typical values 5.0μA , the maximum 9.0μA ($V_C=3.2\text{V}, V_{DD}=6.4\text{V}$)
● At sleeping conditions	the maximum 0.1μA ($V_C=1.7\text{V}, V_{DD}=3.4\text{V}$)

(4) connect the charger terminal resistance to high pressure design (CS pin and OC pin) (absolute maximum rating 33 V)

(5) 0 V battery charge function: can choose to "allow" or "forbide"

(6) Wide working temperature range: $-40^{\circ}\text{C} \sim +85^{\circ}\text{C}$

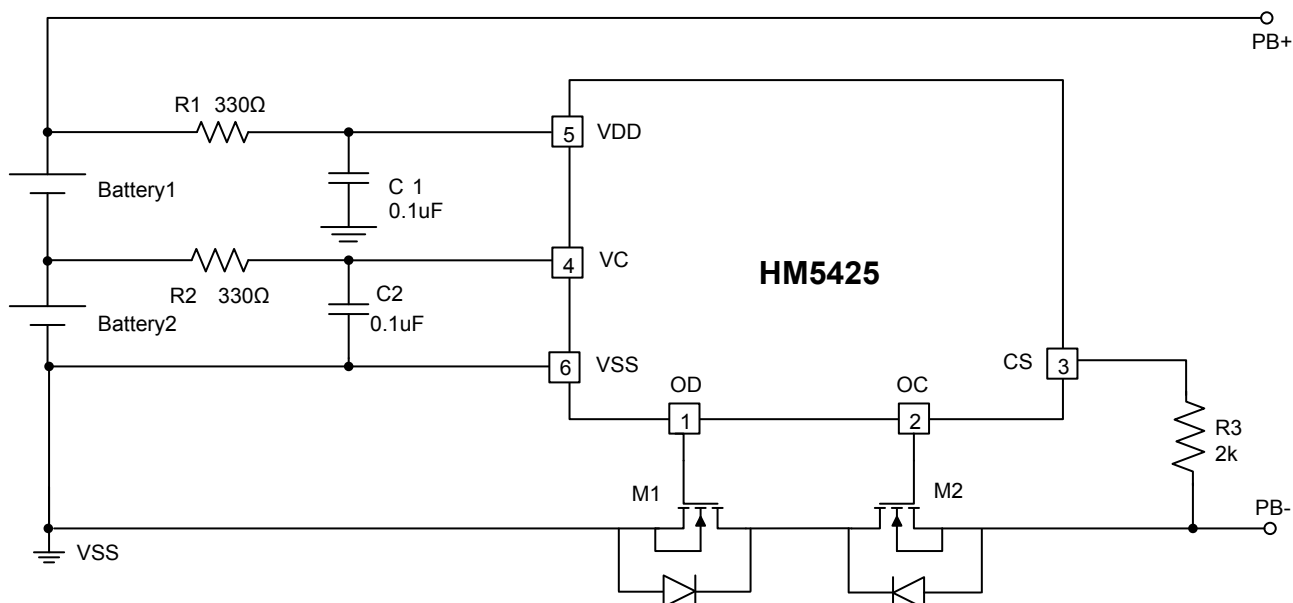
Applications

- intercom
- A miner's lamp
- MID

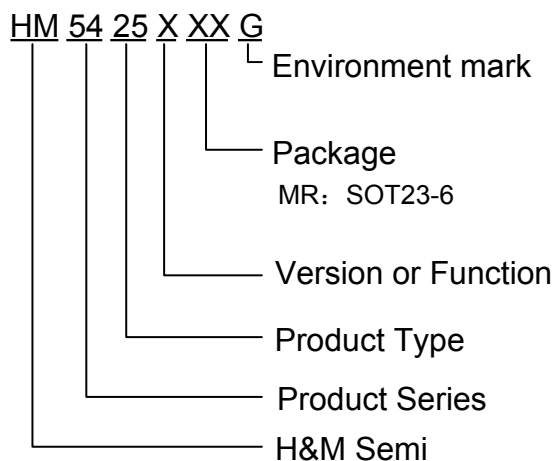
Package

- 6-pin SOT23-6

Typical Application Circuit

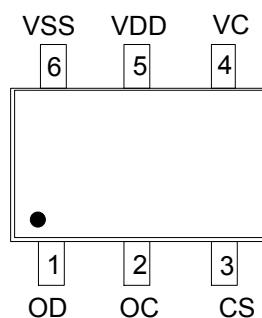


Selection Guide



Product model	Overcharge detector voltage	Overcharge release voltage	Overdischarge detector voltage	Overdischarge release voltage	Overcurrent detector voltage of discharge	Overcurrent detector voltage of charge	0V battery charge	Sleep or no
HM5425	3.65±0.025 V	3.45±0.05 V	2.00±0.08V	2.50±0.1V	200±30mV	-200±30mV	available	sleep

Pin Configuration



SOT23-6

Pin Assignment

PIN Num.	Symbol	Description
1	OD	MOSFET gate connection pin for discharge control
2	OC	MOSFET gate connection pin for charge control
3	CS	Input pin for current sense, charger detect pin
4	VC	Input pin of the center voltage between two-cell
5	VDD	Power supply pin, Battery 1 the anode connection terminal
6	VSS	Ground pin , Battery 2 the cathode connection terminal

The chip block diagram

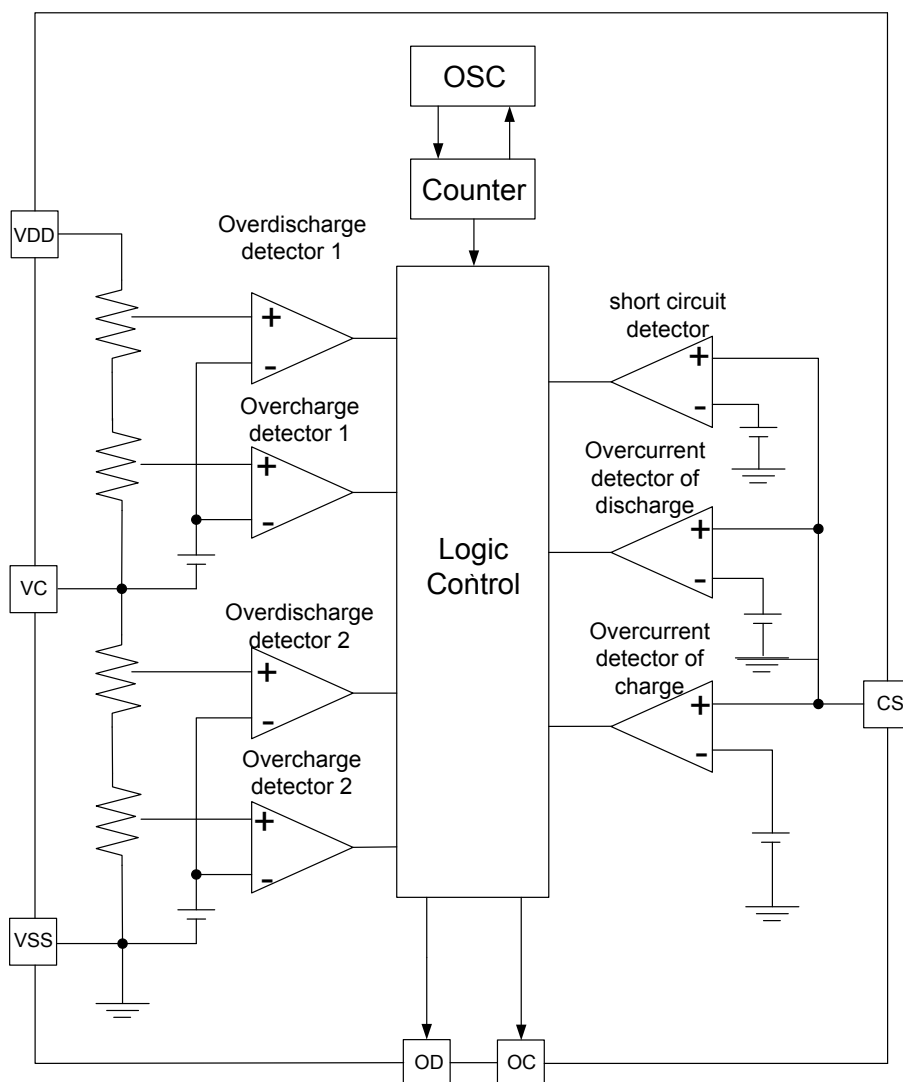


Diagram.1 Module function diagram

Absolute Maximum Ratings

Item	Symbol	Limit value	Unit
Input voltage between VDD and VSS pin	V_{DD}	-0.3~10	V
OC output pin voltage	V_{OC}	$V_{DD}-33 \sim V_{DD}+0.3$	V
OD output pin voltage	V_{OD}	$-0.3 \sim V_{DD}+0.3$	V
CS input pin voltage	V_{CS}	$V_{DD}-33 \sim V_{DD}+0.3$	V
Operating Temperature Range	T_{op}	-40~85	°C
Storage Temperature Range	T_{ST}	-55~150	°C
Maximum junction temperature	T_J	-40~150	°C
Package power dissipation	P_D	0.63	W
Thermal resistance (Junction to air)	θ_{JA}	200	°C/W

Note: the absolute maximum rating is the biggest physical damage limit value of the product can withstand, in any case, please do not exceed the rating.

HM5425 Electrical Characteristics (VSS=0V, Ta=25°C unless otherwise specified)

Item	Symbol	Condition	Min	Typ	Max	Unit
Input voltage						
Operating voltage between VDD pin and VSS pin	V _{DS1}	-	1.5	-	10	V
Operating voltage between VDD pin and CS pin	V _{DS2}	-	1.5	-	33	V
Consumption current(with sleeping function)						
Supply Current	I _{DD}	VC=3.2V,VDD=6.4V	-	5.0	9.0	uA
sleeping Current	I _{PD}	VC=1.7V,VDD=3.4V	-	-	0.1	uA
Detection and release voltage						
Overcharge detection voltage n (1, 2)	V _{CUn}	3.6~4.0V , option	V _{CUn} -0.025	V _{CUn}	V _{CUn} +0.025	V
Overcharge release voltage n (1, 2)	V _{CRn}	3.4~3.8V , option	V _{CRn} -0.05	V _{CRn}	V _{CRn} +0.05	V
Overdischarge detection voltage n (1, 2)	V _{DLn}	1.8~2.2V , option	V _{DLn} -0.08	V _{DLn}	V _{DLn} +0.08	V
Overdischarge release voltage n (1, 2)	V _{DRn}	1.8~2.5V , option	V _{DRn} -0.1	V _{DRn}	V _{DRn} +0.1	V
Overcurrent detection voltage of discharge	V _{DIP}	-	V _{DIP} -30	V _{DIP}	V _{DIP} +30	mV
Short circuit detection Voltage	V _{SHORT}	VDD-VSS=6.4V	0.6	1.0	1.4	V
Overcurrent detection voltage of charge	V _{CIP}	-	V _{CIP} -30	V _{CIP}	V _{CIP} +30	mV
Detection delay time						
Overcharge delay Time	T _{OC}	-	700	1000	1300	ms
Overdischarge delay Time	T _{OD}	-	70	110	150	ms
Overcurrent delay Time of discharge	T _{DIP}	-	6	10	14	ms
Overcurrent delay Time of charge	T _{CIP}	-	4	7	10	ms
Short circuit delay time	T _{SHORT}	-	150	250	400	us
Output voltage						
OC Pin Output "H" Voltage	V _{OCH}	-	VDD-0.1	VDD-0.02	-	V
OC Pin Output "L" Voltage	V _{OCL}	-	-	0.2	0.5	V
OD Pin Output "H" Voltage	V _{ODH}	-	VDD-0.1	VDD-0.02	-	V
OD Pin Output "L" Voltage	V _{ODL}	-	-	0.2	0.5	V
0V battery charge function(allow or forbide)						
Charger start voltage	V _{0VCL}	Allow to 0V battery charge	1.2	-	-	V
Battery voltage	V _{0VCH}	Forbide to 0V battery charge	-	-	0.5	V

Description of operation

a. Normal Status

HM5425 series IC monitor the voltage of the battery connected between the VDD pin and VSS pin and the voltage difference between the CS pin and VSS pin to control charging and discharging. When the cell1 and cell2 voltage is in the range from overdischarge detection voltage (V_{DLn}) to overcharge detection voltage (V_{CU_n}), and the CS pin voltage is in the range from the overcurrent of charge detection voltage (V_{CIP}) to overcurrent of discharge detection voltage (V_{DIP}), the IC turns both the charging and discharging control MOSFET on. This condition is called the normal status. Under this condition, charging and discharging can both be carried out freely.

Notice: Discharging may not be enacted when the battery is first time connected. To regain normal status, CS and VSS PIN must be shorted or the charger must be connected.

b. Overcharge Status

Under normal working state of the battery, in the process of charging, the connection between the VDD and VC terminal voltage of battery 1 or connection with VSS in VC between terminal voltage of battery 2, more than a charging detection voltage (V_{CU_n}), and the state last time over charging protection delay time (T_{OC}), the OC terminal of IC output voltage from high level to low level, close the charging control with MOSFET (OC terminal) to stop charging, this state is called the "overcharge status".

Overcharging status in the following two cases can be released, the OC terminal output voltage from low level to high level, open charging with MOSFET control.

(1) Disconnect a charger, the voltage of the battery cell1 and the voltage of the battery cell2 are equal to or lowers than the overcharge release voltage (V_{CRn}) due to self-discharge.

(2) Disconnect a charger and When load is connected and the battery voltage falls below the overcharge protection voltage (V_{CU_n}).

Notice:

- ① Further, either or both voltage of Cell1 and Cell2 is higher than the overcharge detector threshold, when a charger is connected overcharge state still keep on even if the voltage of the battery cell1 and the voltage of the battery cell2 are lowers than the overcharge release voltage (V_{CRn}).
- ② When either or both voltage of Cell1 and Cell2 is higher than the overcharge detector voltage (V_{CU_n}), remove a charger and connect some load, if both voltage of Cell1 and Cell2 are higher than the overcharge release voltage (V_{CU_n}), however, load current can flow through the parasitic diode of the external charge control Nch MOSFET. After that, when the voltage of the battery cell1 and the voltage of the battery cell2 are equal to or lowers than the

overcharge release voltage (V_{CRn}), OC becomes “H” from “L”, turns the external charging control Nch MOSFET on.

③when the voltage of Cell1 or Cell2 level becomes equal or higher level than overcharge detection voltage (V_{CU_n}), if these voltages would be back to a level lower than the overcharge detector threshold within a time period of the output delay time (T_{OC}), the overcharge is not detected.

④OC pin high level is on the way to VDD level, OC pin low level is next to the CS level.

c. Over discharge and sleep status

Batteries under normal operation mode, voltage of cell 1 that connected to VDD and VC pin or voltage of cell 2 that connected to VC and VSS pin drops lower than overdischarge detection voltage (V_{DLn}) and the state continues longer than overdischarge detection delay time (T_{OD}) during discharging, ME4212 series will turn the OD pin output voltage from high level to low level and turn the discharging control MOSFET off (OD pin) so as to stop discharging. This state is called the “Overdischarge Status”.

When the discharging control MOSFET is off, CS pin voltage is pulled up by IC internal resistor to VDD, reducing IC power consumption value to that of in the sleep mode .

The overdischarge status will be released by two following cases., OD pin output voltage turns from low level to high level, turning discharging control MOSFET on .

(1) If CS pin voltage lowers than overcurrent of charge detection voltage (V_{CIP}), when a charger is connected, both voltage of cell 1 and cell 2 are higher than overdischarge detection voltage (V_{DLn}), the overdischarge status is released and back to normal operation mode.

(2) If CS pin voltage is higher than overcurrent of charge detection voltage of charge (V_{CIP}) when a charger is connected, both voltage of cell 1 and cell 2 are higher than overdischarge release voltage (V_{DRn}), the overdischarge status is released and back to normal operation mode.

Note:

①I when the voltage of Cell1 or Cell2 level becomes equal or lower level than overdischarge detection voltage (V_{DLn}), if these voltages would be back to a level higher than the overdischarge detector threshold within a time period of the output delay time (T_{OD}), the overdischarge is not detected.

②OD pin high level is on the way to VDD level, OD pin low level is next to the VSS level.

d. Overcurrent status of discharge (Overcurrent of discharge & Short circuit)

The IC continuously monitor discharge current by examining CS pin voltage when batteries under normal operation. Once the voltage of CS pin exceeds that of overcurrent of discharge detection voltage (V_{DIP}) and this status lasts longer than overcurrent of discharge delay time (T_{DIP}), then voltage output of OD pin changes from high level to low level, the discharging control MOSFET (OD pin) is disabled and discharge is stopped. This status is

called “Overcurrent status of discharge”.

When CS pin voltage excels short circuit detection voltage (V_{SHORT}) and this status lasts longer than short circuit delay time (T_{SHORT}), voltage output of OD pin changes from high level to low level. The discharging control MOSFET (OD pin) is disabled and discharge is stopped, this status is called “Short Circuit Status”.

Overcurrent status of discharge and short current status are released while the connected impedance between PB+ and PB- is larger than 450k Ω (typ.). Additionally, when a charger is connected, even the impedance between PB+ and PB- lowers than 450k Ω (typ.) and CS pin voltage lowers than overcurrent detection voltage of discharge (V_{DIP}), the overcurrent status of discharge or short circuit status will still be released and back to normal operation mode.

e. Overcurrent of charge status

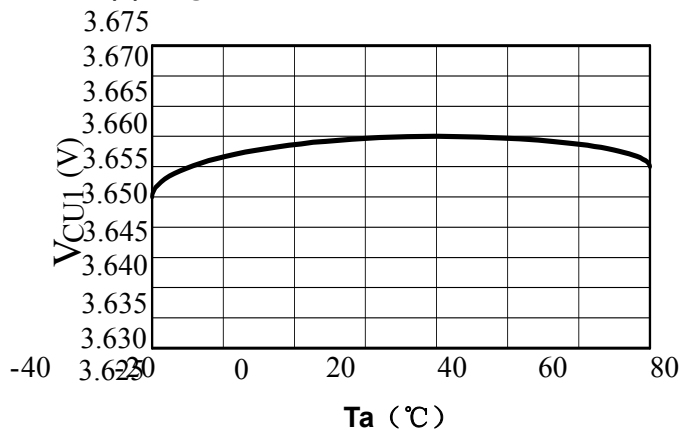
When CS pin voltage lowers than overcurrent of charge detection voltage (V_{CIP}) and this status lasts longer than overcurrent of charge delay time (T_{CIP}) during charge process of batteries under normal operation, OC pin voltage output will change from high level to low level. The charging control MOSFET (OC pin) is disabled and charge is stopped, his status is called “ Overcurrent of charge Status”.

If CS pin voltage increases higher than overcurrent of charge detection voltage (V_{CIP}) by disconnecting charger after entering overcurrent of charge status, the overcurrent of charge status will be released and back to normal operation mode.

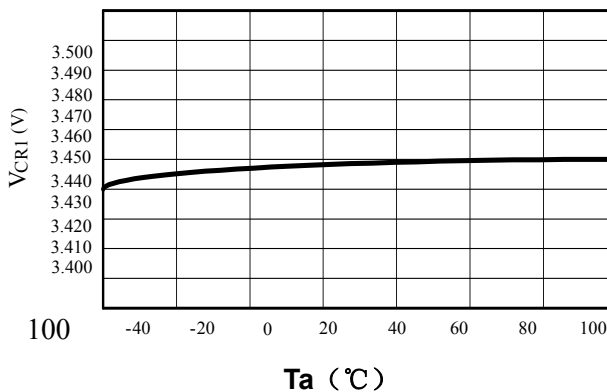
Typical performance curves

a. Overcharge Detection / Release Voltage, Overdischarge Detection / Release Voltage, Overcurrent of discharge Detection Voltage/Short circuit Detection Voltage, Overcurrent of charge Detection Voltage and Delay Time VS Temperature.

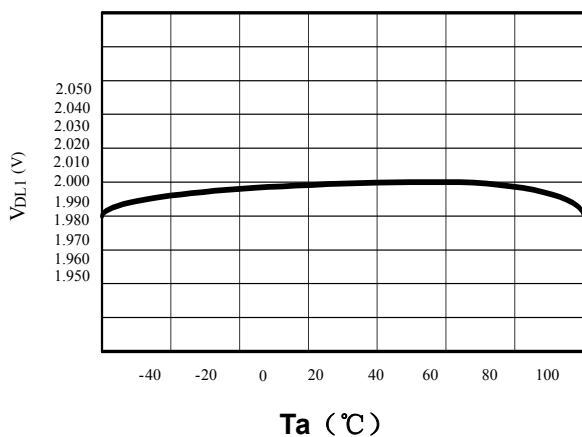
(1) V_{CU1} VS T_a



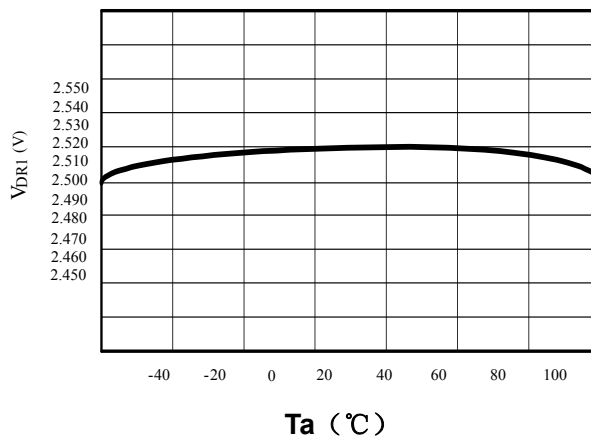
(2) V_{CR1} VS T_a



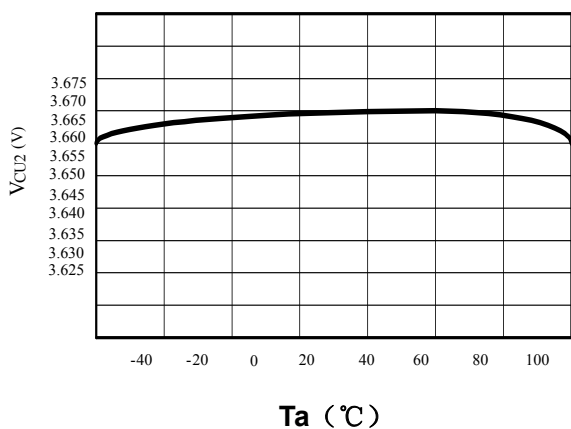
(3) V_{DL1} VS T_a



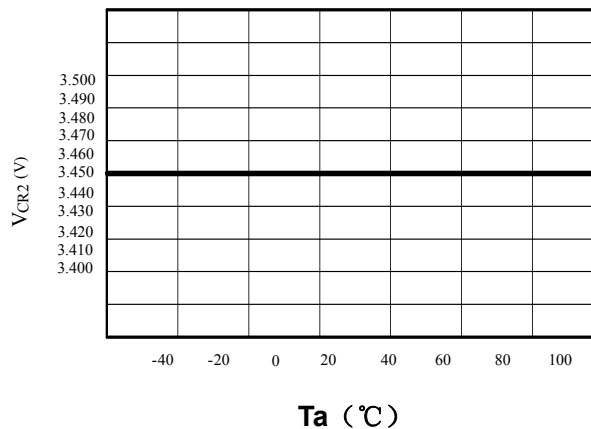
(4) V_{DR1} VS T_a



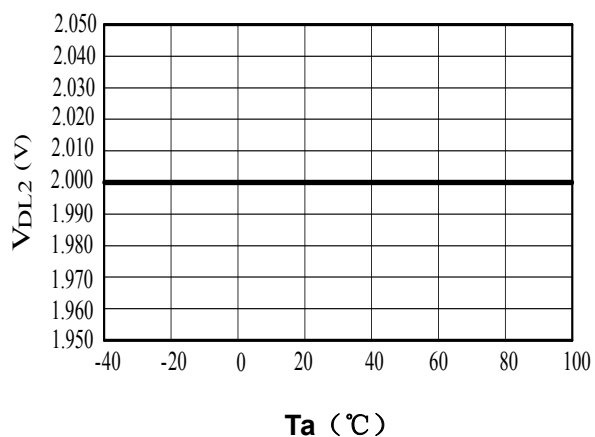
(5) V_{CU2} VS T_a



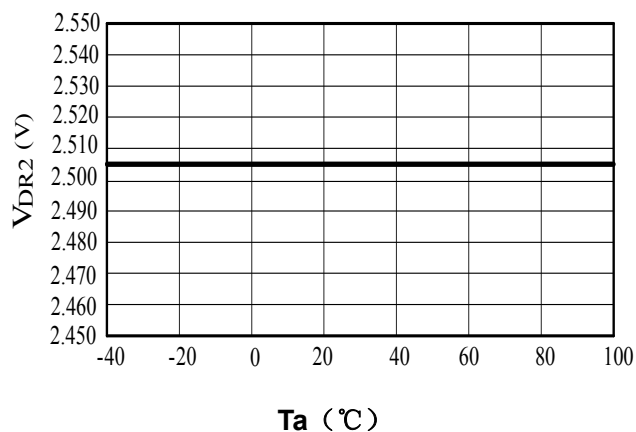
(6) V_{CR2} VS T_a



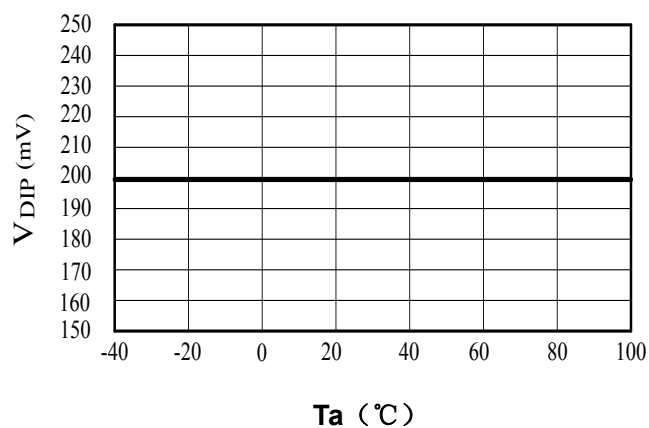
(7) V_{DL2} VS T_a



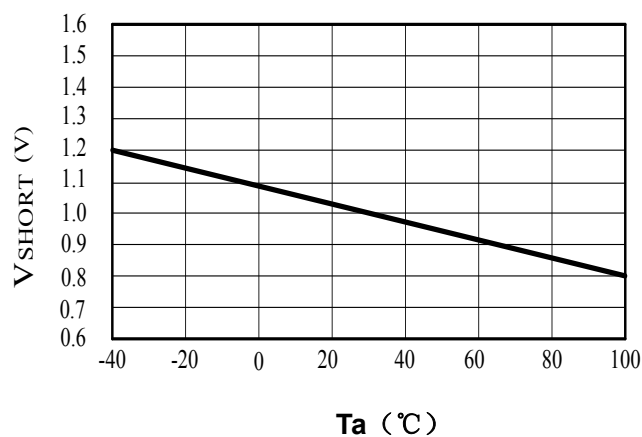
(8) V_{DR2} VS T_a



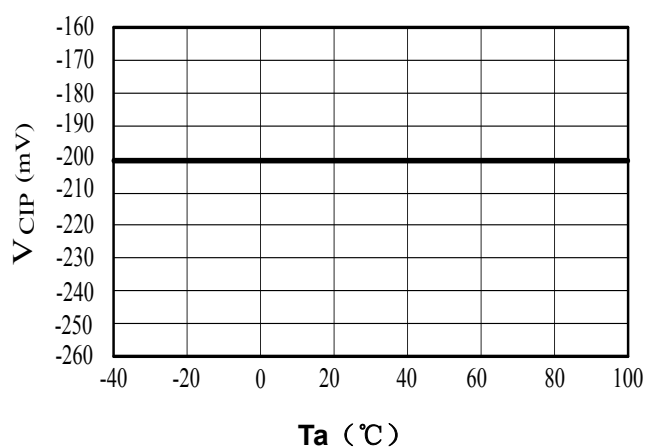
(9) V_{DIP} VS T_a



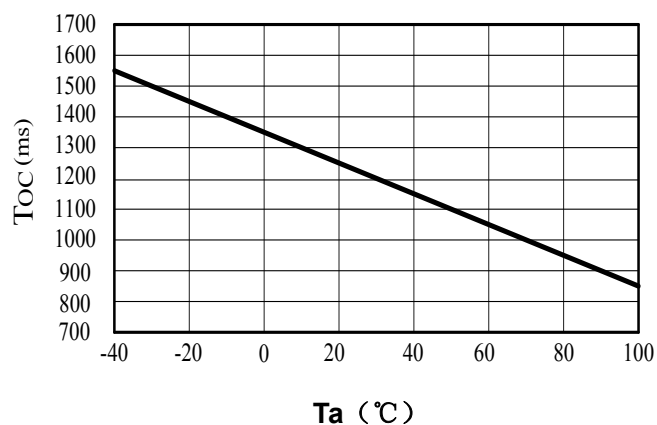
(10) V_{SHORT} VS T_a



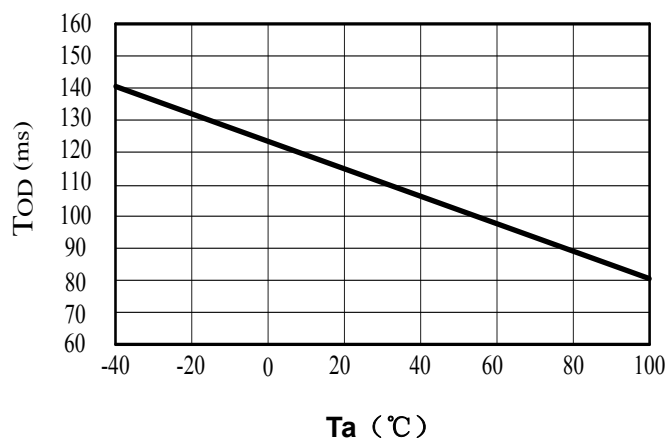
(11) V_{CIP} VS T_a



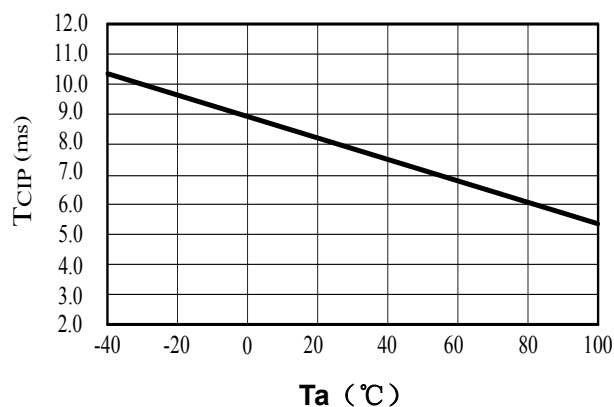
(12) T_{OC} VS T_a



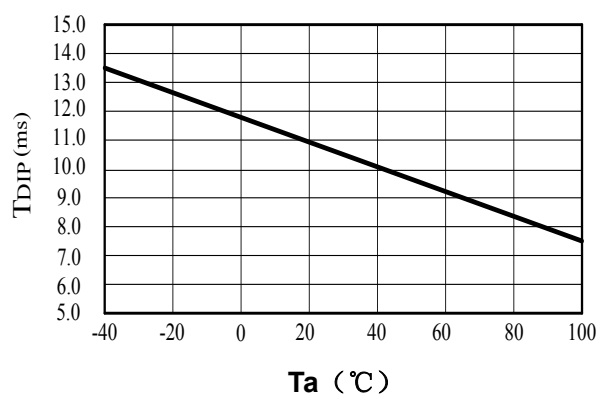
(13) T_{OD} VS T_a



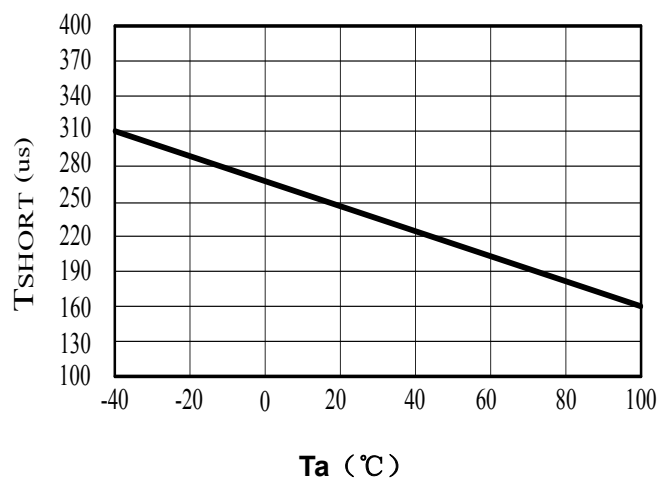
(14) T_{CIP} VS T_a



(15) T_{DIP} VS T_a

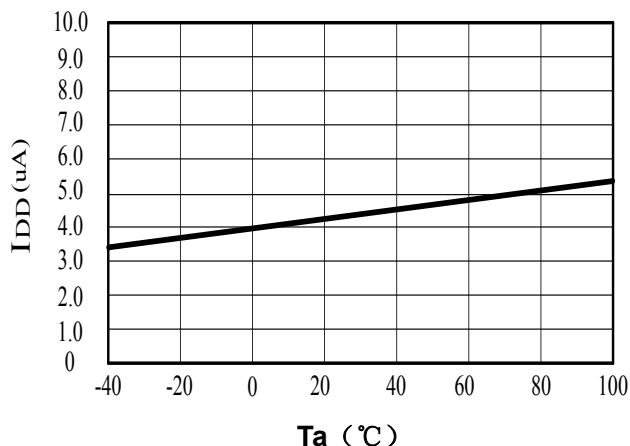


(16) T_{SHORT} VS T_a

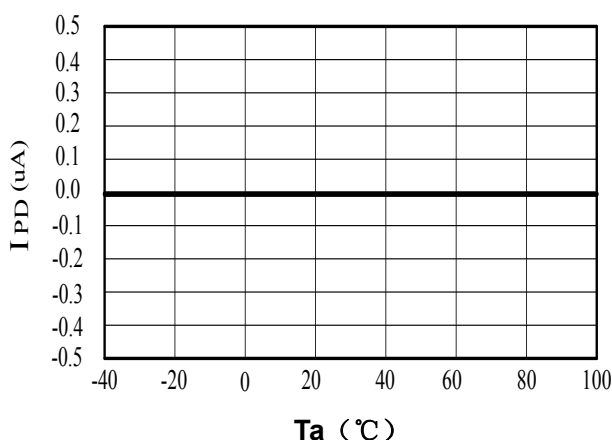


b. Current consumption VS Ta

(17) I_{DD} VS Ta



(18) I_{PD} VS Ta



The application of information

Device Name	Category	Purpose	Min.	Typ.	Max.	Instructions
R1	Resistor	limit current, stabilize VDD and strengthen ESD protection	100Ω	330Ω	470Ω	1
R2	Resistor	limit current, stabilize VC and strengthen ESD protection	100Ω	330Ω	470Ω	1
R3	Resistor	limit current	1KΩ	2KΩ	4KΩ	2
C1	Capacitor	Filter, stabilize VDD	0.01uF	0.1uF	1.0uF	3
C2	Capacitor	Filter, stabilize VC	0.01uF	0.1uF	1.0uF	3
M1	N-MOSFET	Discharge control	-	-	-	4
M2	N-MOSFET	Charge control	-	-	-	5

1、If R1 or R2 connects with an over-spec resistor, battery accuracy may be influenced due to R1 or R2 voltage drop that caused by current consumption. When a charger is connected in reversed, the current flows from the charger to the IC. At this time, if R1 or R2 is too high, the voltage between VDD pin and VSS pin may exceed the absolute maximum rating.

2、If R3 connects with an over-spec resistor, the charging current may not be cut off when a high-voltage charger is connected. Please select as large a resistor as possible to control current when a charger is connected in reversed.

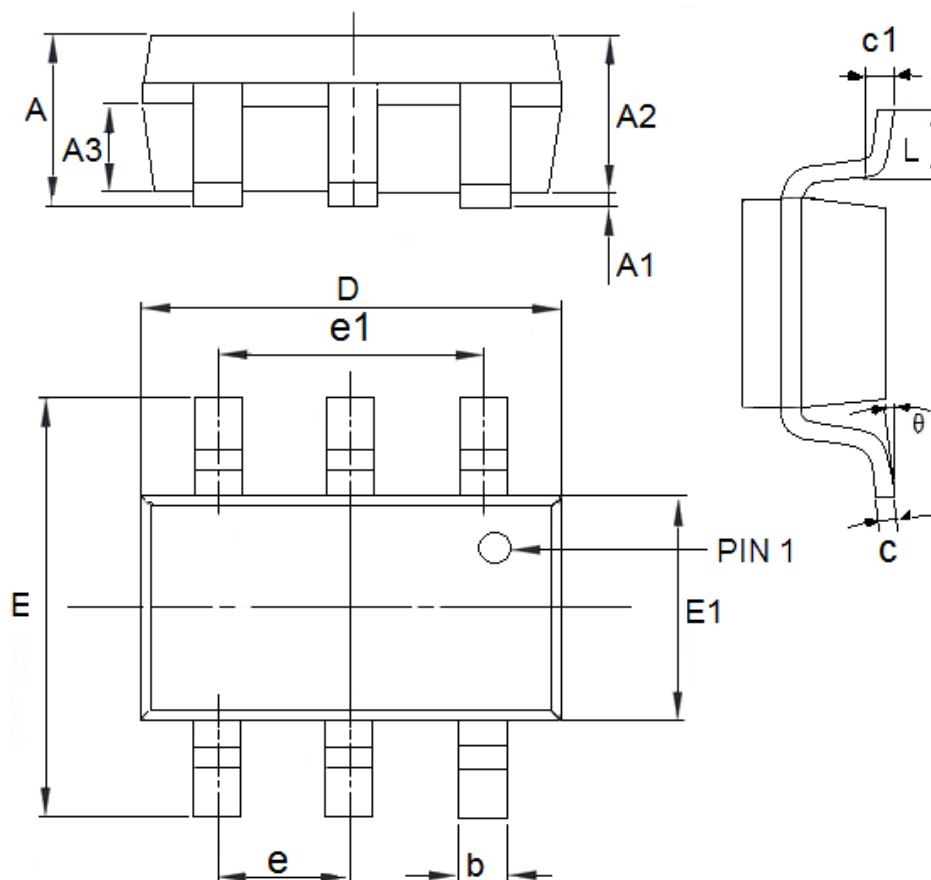
3、C1 & C2 can stabilize the supply voltage of VDD and VC , so the value of C1 & C2 should be equal to or more than 0.01μF.

4、If a MOSFET with a threshold voltage that is the same or more than overdischarge detection voltage is applied, discharging may be stopped before overdischarge is detected.

5、If the withstanding voltage between the gate and source is lower than the charger voltage, the N-MOSFET may be destroyed.

Packaging information

- Package type: SOT23-6



DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	1.05	1.45	0.0413	0.0571
A1	0	0.15	0.0000	0.0059
A2	0.9	1.3	0.0354	0.0512
A3	0.55	0.75	0.0217	0.0295
b	0.25	0.5	0.0098	0.0197
c	0.1	0.25	0.0039	0.0098
D	2.7	3.12	0.1063	0.1228
e1	1.9(TYP)		0.0748(TYP)	
E	2.6	3.1	0.1024	0.1220
E1	1.4	1.8	0.0551	0.0709
e	0.95(TYP)		0.0374(TYP)	
L	0.25	0.6	0.0098	0.0236
θ	0	8°	0.0000	8°
c1	0.2(TYP)		0.0079(TYP)	