RICOH R5437L Series

1 to 3 Cells Li-Ion Battery Protection IC for Secondary Protection

No. EA-416-210518

OUTLINE

The R5437L is an overcharge protection IC for 1 to 3 serial cells Li-ion / Li-polymer rechargeable battery. This device provides the high-accuracy voltage detection function and the shutdown function can reduce the supply current to the minimum when all cell's voltage becomes less than the shutdown detection voltage.

FEATURES

•	High Voltage Tolerant Process
	Absolute Maximum Ratings 26 V
•	Low Supply Current
	During Operation, Cell-voltage: 3.9 V, 3-Cells ········ Typ. 0.85 μA
•	High-accuracy Voltage Detection
	Overcharge Detector Threshold (V _{DET1n} ⁽¹⁾)··········· 4.10 V to 4.65 V, in 5 mV step
	Overcharge Detector Threshold Accuracy $\dots \pm 0.02 \text{ V}$ (Ta = 25°C)
	± 0.025 V (0°C ≤ Ta ≤ 60°C)
	Overcharge Release Voltage (V _{REL1n} ⁽¹⁾)······ V _{DET1n} -0V to V _{DET1n} -0.5V, in 50 mV step
	Overcharge Detection Delay Time 2-, 4-, or 6-sec with Delay Time Shortening Function ⁽²⁾
	Overcharge Release Voltage Condition Voltage Release Type
•	COUT Output (CMOS Output, Active-high) ······ Typ. 4.7 V
•	Shutdown Functions
	Shutdown Detector Threshold Typ. 3.5 V ±0.3 V
	Shutdown Current······
•	1 to 3 Cells Selectable Battery Protection
•	Compact Package
	DFN 1814-6C 1.4mm x 1.8mm

APPLICATIONS

• Li-Ion or Li-Polymer Battery Protection

⁽¹⁾ V_{DET1n} , V_{REL1n} : n =1, 2, 3 ⁽²⁾ The delay time can be reduced down to approx. 1/90 by applying a 4 V ± 0.2 V to the VDD – VC1 pins.

No. EA-416-210518

SELECTION GUIDE

The overcharge and the delay time are user-selectable options.

Selection Guide

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R5437Lxxx\$*-TR	DFN1814-6C	5,000 pcs	Yes	Yes

xxx: Specify the combination of the overcharge detector threshold (V_{DET1n}) and the overcharge release voltage (V_{REL1n})⁽¹⁾.

\$: Specify the combination of the overcharge detection delay time (t_{VDET1}) and the overcharge release delay time (t_{VREL1}). Refer to *Delay Time Code Table* for details.

Delay Time Code Table

Code	t _{VDET1} (s)	t _{VREL1} (ms)
А	2	16
В	4	16
С	6	16

*: Specify the function code.

Function Code Table

Code	Overcharge Released Condition	COUT Output		
А	Voltage Release	CMOS	"H" Active	

⁽¹⁾ Refer to *Product Code Table* for details.

 $^{^{(2)}}$ V_{DET1n}, V_{REL1n}: n = 1, 2, 3

No. EA-416-210518

BLOCK DIAGRAM



R5437L Block Diagram

No. EA-416-210518

PIN DESCRIPTIONS

DFN1814-6C



R5437L Pin Description

Pin No.	Symbol	Description	
1	VC1	CELL1 Plus Pin	
2	VC2	CELL2 Plus Pin	
3	VSS	IC Ground Pin	
4	VC3	CELL3 Plus Pin	
5	VDD	Power Supply Pin	
6	COUT	Overcharge Detection Output Pin	

No. EA-416-210518

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings

(Ta = 25°C, Vss = 0 V)

Symbol	ltem	Rating	Unit
Maa	Bower Supply Veltage	V _{C1} -0.3 to V _{C1} +6.5	V
V DD	VDD Power Supply Voltage	V _{C1} -0.3 to 26	V
V _{C1}	CELL1 Plus Pin Input Voltage	V_{C2} -0.3 to V_{C2} +6.5	V
V _{C2}	CELL2 Plus Pin Input Voltage	V_{C3} -0.3 to V_{C3} +6.5	V
V _{C3}	CELL3 Plus Pin Input Voltage	-0.3 to 6.5	V
Vcout	COUT Pin Output Voltage	-0.3 to V _{OH1} +0.3	V
PD	Power Dissipation (Standard Land Pattern)	150	mW
Тј	Junction Temperature Range	-40 to 125	°C
Tstg	Storage Temperature Range	-55 to 125	°C

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause permanent damage and may degrade the lifetime and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

RECOMMENDED OPERATING CONDITION

Symbol	Item	Rating	Unit
V _{DD}	Operating Input Voltage	1.5 to 20 / V _{C1} +5 V	V
Та	Operating Temperature Range	-40 to 85	°C

RECOMMENDED OPERATING CONDITIONS

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

No. EA-416-210518

ELECTRICAL CHARACTERISTICS

VCELLn = CELLn (Ex. VCELL1 is a voltage difference between VC1 and VC2) n = 1, 2, 3, unless otherwise noted The specifications surrounded by are guaranteed by Design Engineering at $0^{\circ}C \le Ta \le 60^{\circ}C$.

R5437L Electrical Characteristics (Ta = 25°C)							
Symbol	Item	Conditions	Min.	Тур.	Max.	Unit	Circuit
V _{DET1n}	CELLn Overcharge Detection Voltage	Detect rising edge of supply voltage	V _{DET1n} -0.020V V _{DET1n} -0.025V	VDET1n	VDET1n +0.020V VDET1n +0.025V	V	A
V_{REL1n}	CELLn Overcharge Release Voltage	Detect falling edge of supply voltage	V _{REL1n} -0.050V	V_{REL1n}	V _{REL1n} +0.050V	V	А
t _{VDET1}	Overcharge Detection Delay Time	$\begin{array}{l} V_{\text{CELLn}}=3.9 \text{ V} (n=2,3) \\ V_{\text{CELL1}}=3.9 \text{ V} \rightarrow 4.7 \text{ V} \end{array}$	t _{VDET1} х 0.8	t _{vdet1}	tvdet1 x 1.2	s	В
t _{VREL1}	Overcharge Release Delay Time	$\begin{array}{l} V_{\text{CELLn}}=3.9 \text{ V} (n=2,3) \\ V_{\text{CELL1}}=4.7 \text{ V} \rightarrow 3.9 \text{ V} \end{array}$	12.8	16	19.2	ms	В
V _{SHT}	Shutdown Detection Voltage	Detect falling edge of supply voltage	3.2	3.5	3.8	V	С
	Cout Pch. ON Voltage 1	I _{OH} =0 μ A,V _{CELLn} = 4.7 V	4.0	4.7	5.4		
Voh1		$I_{OH}=0\mu A, V_{CELLn} = 4.7 V$ (n=1, at 1 cell protection)		V _{DD}	D		D
V _{OH2}	Cout Pch. ON Voltage 2	I _{OH} = -50μΑ, V _{CELLn} = 4.7V	V _{ОН1} -0.5V	Vон1 -0.1 V		V	Е
V _{OL}	COUT Nch. ON Voltlage	I_{OL} =50µA,V _{CELLn} =3.9 V		0.1	0.5	V	F
I _{SHT}	Shutdown Current	$V_{CELLn} = 3.1 V$			0.1	μA	G
Iss	Supply Current	V _{CELLn} = 3.9 V		0.85	1.7	μA	G

R5437L Electrical Characteristics

TEST CIRCUITS



⁽¹⁾ Refer to *TEST CIRCUITS* for detail information.

No. EA-416-210518



Ε

G



D

F





RICOH

THEORY OF OPERATION

Overcharge Detection Circuit, VD1-n (n = 1, 2, 3)

(See the following timing chart)

While the cells are charged, the voltage between VC1 pin and VC2 pin (Cell-1 voltage), the voltage between VC2 pin and VC3 pin (Cell-2 voltage), and the voltage between VC3 pin and VSS pin (Cell-3 voltage) are supervised. If at least one of the cells' voltage becomes equal or more than the overcharge detector threshold, the overcharge is detected, and an external charge control Nch. FET turns on with COUT pin being at "H" level and by cutting a fuse on the charger path, and charge stops.

To reset the overcharge and make the COUT pin level to "L" again after detecting over-charge, in such conditions that a time when all the cells' voltages are down to a level lower than overcharge released voltage. Internal fixed output delay times for overcharge detection and release from over-charge exist. Even if one of voltage of the cells keeps its level more than the overcharge detector threshold, and output delay time passes, overcharge voltage is detected. After detecting overcharge, even if all the cell voltages become equal or less than the released voltage from overcharge within the output delay time of the release from overcharge, then overcharge is not released.

The output type of the COUT pin is CMOS output between VSS and the built-in regulator, and "H" level of COUT pin is the output voltage of the built-in regulator.

Shutdown Function

The voltage between VC1 pin and VC2 pin (Cell-1 voltage), the voltage between VC2 pin and VC3 pin (Cell-2 voltage), and the voltage between VC3 pin and VSS pin (Cell-3 voltage) are supervised. If the cell voltage becomes equal or less than the shutdown detector threshold, the overcharge detector of the cell is halted, as a result, the consumption current of IC itself (Shutdown current) is extremely reduced. If at least one of the cells voltage becomes higher than the shutdown detection voltage, the shutdown detection is released.

Delay Shortening (DS) Function

Applying a voltage of 4 V \pm 0.2 V between VDD and VC1 can shorten the overcharge detection delay time (t_{VDET1}) into approximately 1/90, likewise, the overcharge release delay time (t_{VREL1}) into approximately 1/60.

1-cell/ 2-cell Protection Alternative

By short-circuiting between cells, this device can meet as a protection IC for 1 or 3 cells placed in series. The following table indicates pins to short-circuit depending on protected cells.

Protected Cells	Pins to short-circuit
1-cell protection	VC1 and VC2 pins, and VC3 and VSS pins
2-cell protection	VC1 and VC2 pins, or VC3 and VSS pins

If providing other connections except above short-circuit for 1 or 2 cells protection, perform thorough evaluation using the actual devices.



Overcharge Operation Timing Chart

APPLICATION INFORMATION

Typical Application Circuits in Normal Mode (CMOS Output, Active-high)

As for the order of cell's connection, connect a positive terminal of CELL1 as the end terminal. If connected another terminal, a fuse blowout might be caused by transiently "High" output of the COUT pin.



Typical Application Circuit for 3-cell Protection

No. EA-416-210518



Typical Application Circuit for 2-cell Protection -1



Typical Application Circuit for 2-cell Protection -2

No. EA-416-210518



Typical Application Circuit for 1-cell Protection

Symbol	Тур.	Unit	Range
Rvdd	100	Ω	100 to 1000
R1	1000	Ω	330 to 1000
R2	1000	Ω	330 to 1000
R3	1000	Ω	330 to 1000
CVDD	0.1	μF	0.01 to 1
C1	0.1	μF	0.01 to 1
C2	0.1	μF	0.01 to 1
C3	0.1	μF	0.01 to 1

External Components

No. EA-416-210518

Technical Notes on the Selection Components

- The voltage fluctuation is stabilized with R_{VDD} and C_{VDD}. If a small R_{VDD} is set, in the case of the large transient may happen to the cell voltage, by the flowing current, the IC may be unstable. If a large R_{VDD} is set, by the consumption current of the IC itself, the voltage difference between VDD pin and VC1 pin is generated, and unexpected operation may result. Therefore, the appropriate value range of R_{VDD} is from 100 Ω to 1 kΩ. To make a stable operation of the IC, the appropriate value range of C_{VDD} is from 0.01 µF to 1.0 µF.
- The voltage fluctuation is stabilized with R1 to R3 and C1 to C3. If a R1 to R3 is too large, by the conduction current at detection, the detector threshold may shift higher. Therefore, the appropriate value range of R1 to R3 is equal or less than 1 kΩ. To make a stable operation of the IC, the appropriate value range of C1 to C3 is 0.01 µF or more.
- The typical application circuit diagrams are just examples. This circuit performance largely depends on the PCB layout and external components. In the actual application, fully evaluation is necessary.
- Overvoltage and the over current beyond the absolute maximum rating should not be forced to the protection IC and external components. During the time until the fuse is open after detecting overcharge, a large current may flow through the FET. Select an FET with large enough current capacity in order to endure the large current.
- To connect the SC protector, connect the SC protector to the cell must be the last.

Contact Information for Inquiries regarding SC PROTECTOR

Dexerials Corporation (Sony Chemical & Information Device Company Ltd.) Gate-city Osaki East Tower 8F, 1-11-2 Osaki, Shinagawa, Tokyo, 141-0032 TEL: 03-5435-3946 URL: http://www.dexerials.jp

No. EA-416-210518

TYPICAL CHARACTERISTICS

Part1. vs. Temperature

1) Celln Overcharge Detection Threshold vs. Temperature



3) Overcharge Output delay Time vs. Temperature



4) Released Delay Time from Overcharge vs. Temperature



2) Celln Overcharge Release Voltage vs. Temperature



R5437L306CA VCELLn=3.9V(n=2,3). V_{CELL}1=3.9V→4.7V



5) Celln Shutdown Threshold vs. Temperature



RICOH

No. EA-416-210518

6) COUT Pch. On Voltage (No Load) vs. Temperature



8) COUT Nch. On Voltage vs. Temperature



10) Supply Current vs. Temperature



7) COUT Pch. On Voltage vs. Temperature



9) Shutdown Current vs. Temperature



RICOH



Part2. Supply Current vs. VDD (R5437L306CA) 3-cell Protection Supply Current vs. VDD

R5437L306CA

R5437L

No. EA-416-210518

No. EA-416-210518



Part3. vs. External Resister Dependence (R5437L306CA) Overcharge Detection Voltage / Overcharge Release Voltage vs. R1

Test Circuit

PACKAGE DIMENSIONS

DFN1814-6C

Ver. A





RICOH

- 1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to Ricoh sales representatives for the latest information thereon.
- 2. The materials in this document may not be copied or otherwise reproduced in whole or in part without prior written consent of Ricoh.
- 3. Please be sure to take any necessary formalities under relevant laws or regulations before exporting or otherwise taking out of your country the products or the technical information described herein.
- 4. The technical information described in this document shows typical characteristics of and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under Ricoh's or any third party's intellectual property rights or any other rights.
- 5. The products listed in this document are intended and designed for use as general electronic components in standard applications (office equipment, telecommunication equipment, measuring instruments, consumer electronic products, amusement equipment etc.). Those customers intending to use a product in an application requiring extreme quality and reliability, for example, in a highly specific application where the failure or misoperation of the product could result in human injury or death (aircraft, spacevehicle, nuclear reactor control system, traffic control system, automotive and transportation equipment, combustion equipment, safety devices, life support system etc.) should first contact us.
- 6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
- 7. Anti-radiation design is not implemented in the products described in this document.
- 8. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
- 9. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
- 10. There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact Ricoh sales or our distributor before attempting to use AOI.
- 11. Please contact Ricoh sales representatives should you have any questions or comments concerning the products or the technical information.



Ricoh is committed to reducing the environmental loading materials in electrical devices with a view to contributing to the protection of human health and the environment. Ricoh has been providing RoHS compliant products since April 1, 2006 and Halogen-free products since April 1, 2012.

RICOH RICOH ELECTRONIC DEVICES CO., LTD.

Official website https://www.n-redc.co.jp/en/ Contact us https://www.n-redc.co.jp/en/buy/



Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

Ricoh Electronics:

R5437L305BA-TR R5437L303BA-TR R5437L307CA-TR R5437L301BA-TR R5437L303CA-TR