

Outline

The R5499Z is high voltage tolerance CMOS-based protection IC for over-charge/discharge and over-current of rechargeable one-cell Lithium-ion (Li+)/Lithium polymer battery. The R5499Z can detect over-charge/discharge of Li+ one-cell and excess load current, further include a short circuit protector for preventing large external short circuit current and the excess charge-current. The R5499Z consists of four voltage detectors, a reference unit, a delay circuit, a short circuit detector, an oscillator, a counter, and a logic circuit.

When the R5499Z detects over-charge or over-charge current, the output of COUT pin switches to "L" level, that is, the charger's negative pin level after the internal fixed delay time. When the R5499Z detects over-discharge or excess discharge current, the output of DOUT pin switches to "L" level after the internal fixed delay time.

After detecting over-charge or excess charge current, the R5499Z can be reset and the output of COUT becomes "H" when a charger is disconnected from the battery pack, and the cell voltage becomes lower than over-charge detector threshold.

However, depending on the characteristics of external components such as MOSFETs, release conditions may be not enough just removing a charger from the battery pack. In that case, a kind of load must be set to release the over-charge detect.

If a charger is continuously connected to the battery pack, even if the cell voltage becomes lower than over-charge detector threshold, over-charge state is not released.

After detecting over-discharge voltage, connect a charger to the battery pack, and when the battery supply voltage becomes higher than over-discharge detector threshold, the R5499Z is released and the voltage of DOUT pin becomes "H". If the battery discharges into 0V level, recharge current is accepted. Once after detecting excess discharge-current or short circuit, the R5499Z is released and DOUT level becomes "H" with detaching a battery pack from a load system. After detecting over-discharge, supply current is kept extremely low by halting internal circuits' operation.

When the output of COUT is "H", by setting the V- pin at equal or lower than the delay shortening mode voltage (Typ. -2.0V), the output delay can be shortened. Especially, the delay time of over charge detector can be reduced into approximately 1/110. Thus, testing time of protector circuit board can be reduced. Output type of COUT and DOUT is CMOS.

FEATURES

- Absolute Maximum Rating..... 30V
- Supply current (At normal mode)..... TYP 4.0 μ A
- Supply current (At standby mode)..... MAX 0.1 μ A

Detector thresholds accuracy

- Over-charge detector threshold..... $\pm 12\text{mV}(0^{\circ}\text{C}\sim 50^{\circ}\text{C})$
- Over-discharge detector threshold..... $\pm 2.5\%$
- Excess discharge current threshold..... $\pm 5\text{mV}$
- Excess charge current threshold..... $\pm 15\text{mV}$
- Short detector threshold..... $\pm 50\text{mV}$

Detector thresholds range

- Over-charge detector threshold..... 4.3V~4.6V step of 0.005V
- Over-discharge detector threshold..... 2.0V ~ 3.0V step of 0.005V
- Excess discharge current threshold..... Code_AC: 0.055V~0.080V step of 0.005V
Code_AD: 0.030V~0.050V step of 0.005V
- Excess charge current threshold..... -0.050V~-0.100V step of 0.005V
- Short current threshold..... 0.150V or 0.230V (selectable)

Output delay time

- Over-charge detector Output Delay..... 1.0s
- Over-discharge detector Output Delay..... 32ms
- Excess discharge current detector Output Delay..... 128ms
- Excess charge current detector Output Delay..... 8ms
- Short detector Output Delay..... 250 μ s

Functions

- Output Delay Time Shorting Function..... At C_{OUT} is "H", if V₋ level is set at -2.0V, the Output Delay time of detect the over-charge and over-discharge can be reduced. (Delay Time for over-charge becomes about 1/110 of normal state.)
- Conditions for release over-charge detector..... Latch type
- Conditions for release over-discharge detector..... Latch type
- Package..... WLCSP-6-P4

APPLICATIONS

- Li+ / Li Polymer protector of over-charge, over-discharge, excess-current for battery pack
- High precision protectors for smart-phones and any other gadgets using on board Li+ / Li Polymer battery

Absolute Maximum Ratings

Ta=25°C, Vss=0V

Item	Symbol	Ratings	Unit
Supply Voltage	VDD	-0.3 to 12	V
Input Voltage V- pin Voltage	V-	VDD-30 to VDD+0.3	V
Output Voltage C _{OUT} pin Voltage	V _{COUT}	VDD-30 to VDD+0.3	V
D _{OUT} pin Voltage	V _{DOUT}	Vss-0.3 to VDD+0.3	V
Power Dissipation	PD	150	mW
Operating Temperature	Ta	-40 to 85	°C
Storage Temperature	Tstg	-55 to 125	°C

*Note: Exposure to the condition exceeded Absolute Maximum Ratings may cause the permanent damages and affects the reliability and safety of both device and systems using the device. The functional operations cannot be guaranteed beyond specified values in the recommended conditions.

Electrical Characteristics

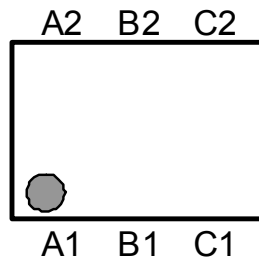
Unless otherwise provided, Ta=25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operating Input Voltage	V _{DD1}	V _{DD} - V _{SS}	1.5		5.0	V
Minimum Operating Voltage for 0V Charging	V _{st}	Voltage Defined as V _{DD} -V ₋ , V _{DD} -V _{SS} =0V			1.8	V
Over-charge Threshold Voltage	V _{DET1}	R1=330Ω, Ta=0°C~50°C*Note1	V _{DET1} -0.012	V _{DET1}	V _{DET1} +0.012	V
Output Delay of Over-charge	t _{VDET1}	V _{DD} = 3.6V → V _{DET1} + 0.05V	t _{VDET1} ×0.7	t _{VDET1}	t _{VDET1} ×1.3	s
Release Delay for VD1	t _{VREL1}	V _{DD} = 4V, V ₋ = 0V → 1V	11	16	21	ms
Over-discharge Threshold	V _{DET2}	Detect falling edge of supply voltage	V _{DET2} ×0.975	V _{DET2}	V _{DET2} ×1.025	V
Output Delay of Over-discharge	t _{VDET2}	V _{DD} =3.6V to 2.0V	t _{VDET2} ×0.7	t _{VDET2}	t _{VDET2} ×1.3	ms
Release Delay for VD2	t _{VREL2}	V _{DD} =3V, V ₋ =3V to 0V	0.7	1.2	1.7	ms
Excess discharge-current threshold	V _{DET3}	Detect rising edge of 'V-' pin voltage	V _{DET3} -0.005	V _{DET3}	V _{DET3} +0.005	V
Output delay of excess discharge-current	t _{VDET3}	V _{DD} =3.0V, V ₋ =0V to V _{DET3} +0.01V	t _{VDET3} ×0.7	t _{VDET3}	t _{VDET3} ×1.3	ms
Output delay of release from excess discharge-current	t _{VREL3}	V _{DD} =3.0V, V ₋ =3V to 0V	0.7	1.2	1.7	ms
Short Protection Voltage	V _{short}	V _{DD} =3.0V	V _{short} -0.05	V _{short}	V _{short} +0.05	V
Delay Time for Short Protection	t _{short}	V _{DD} =3.0V, V ₋ =0V to 0.5V	150	250	350	μs
Reset Resistance for Excess Current Protection	R _{short}	V _{DD} =3.6V, V ₋ =1.0V	20	45	70	kΩ
Excess charge-current threshold	V _{DET4}	Detect falling edge of 'V-' pin voltage	V _{DET4} -0.015	V _{DET4}	V _{DET4} +0.015	V
Output delay of excess charge-current	t _{VDET4}	V _{DD} =3.0V, V ₋ =0V to -1V	t _{VDET4} ×0.7	t _{VDET4}	t _{VDET4} ×1.3	ms
Output delay of release from excess charge-current	t _{VREL4}	V _{DD} =3.0V, V ₋ =-1V to 0V	0.7	1.2	1.7	ms
Delay Time Shortening Mode Voltage	V _{DS}	V _{DD} =3.6V	-2.6	-2.0	-1.4	V
Nch ON-Voltage of C _{OUT}	V _{oL1}	I _{ol} =50μA, V _{DD} = 4.55V		0.4	0.5	V
Pch ON-Voltage of C _{OUT}	V _{oH1}	I _{oh} =-50μA, V _{DD} =3.9V	3.4	3.7		V
Nch ON-Voltage of D _{OUT}	V _{oL2}	I _{ol} =50μA, V _{DD} = 1.9V		0.2	0.5	V
Pch ON-Voltage of D _{OUT}	V _{oH2}	I _{oh} =-50μA, V _{DD} =3.9V	3.4	3.7		V
Supply Current	I _{DD}	V _{DD} =3.9V, V ₋ =0V		4.0	8.0	μA
Standby Current	I _{standby}	V _{DD} =2.0V			0.1	μA

- : 'Note1' Considering of variation in process parameters, we compensate for this characteristic related to temperature by laser-trim, however, this specification is guaranteed by design, not mass production tested.

PIN CONFIGURATIONS

R5499Z : WLCSP-6-P4



PIN DESCRIPTION

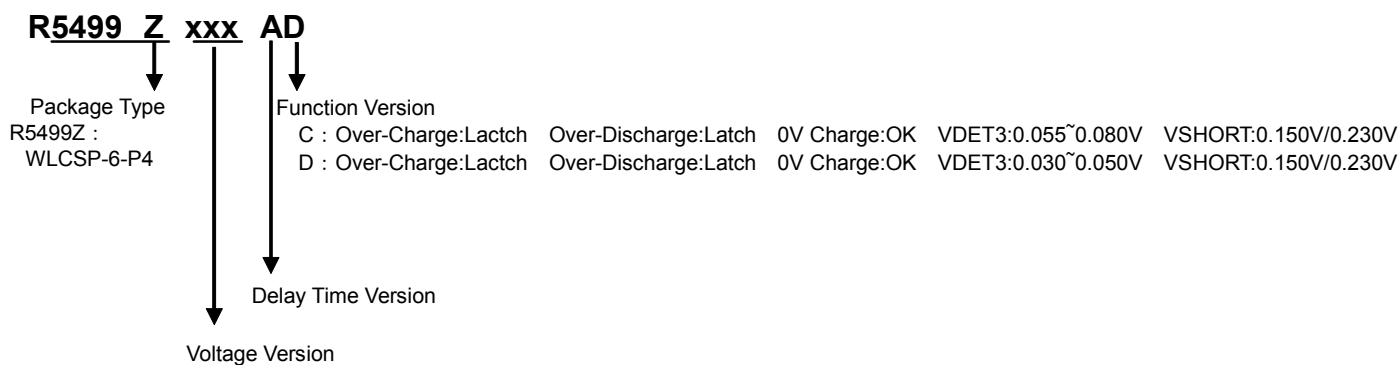
Pin No.	Symbol	Description
A1	V-	Charger negative Input Pin
B1	V _{DD}	Power supply pin, the substrate voltage level of the IC.
C1	V _{SS}	Ground Pin. The ground pin of the IC.
A2	C _{OUT}	Output Pin of Over-charge detection, CMOS output
B2	NC	No Connection (Open or connect with V _{SS})
C2	D _{OUT}	Output Pin of Over-discharge detection, CMOS output

R5499 SERIES

SELECTION GUIDE

In the R5499 Series, input threshold of over-charge, over-discharge, excess discharge current, and excess charge current can be designated.

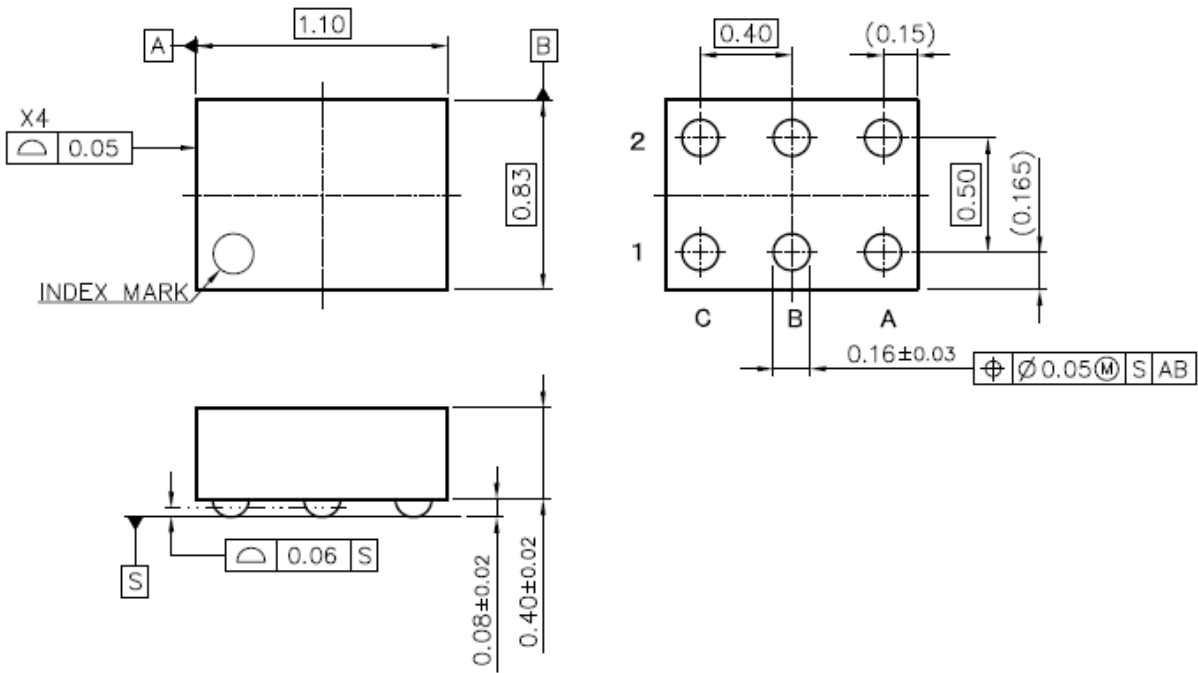
Part Number is designated as follows:



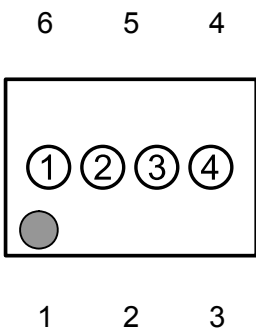
Code	Return from Over-Charge	Return from Over-Discharge	VDET3	VSHORT	tVdet1 (s)	tVdet2 (ms)	tVdet3 (ms)	tVdet4 (ms)	tShort (μs)	0V Charge
R5499Z xxx AC	Latch	Latch	0.055V ~0.080V	0.150V /0.230V	1	32	128	8	250	OK
R5499Z xxx AD	Latch	Latch	0.030V ~0.050V	0.150V /0.230V	1	32	128	8	250	OK

Package Dimensions

R5499Z : WLCSP-6-P4



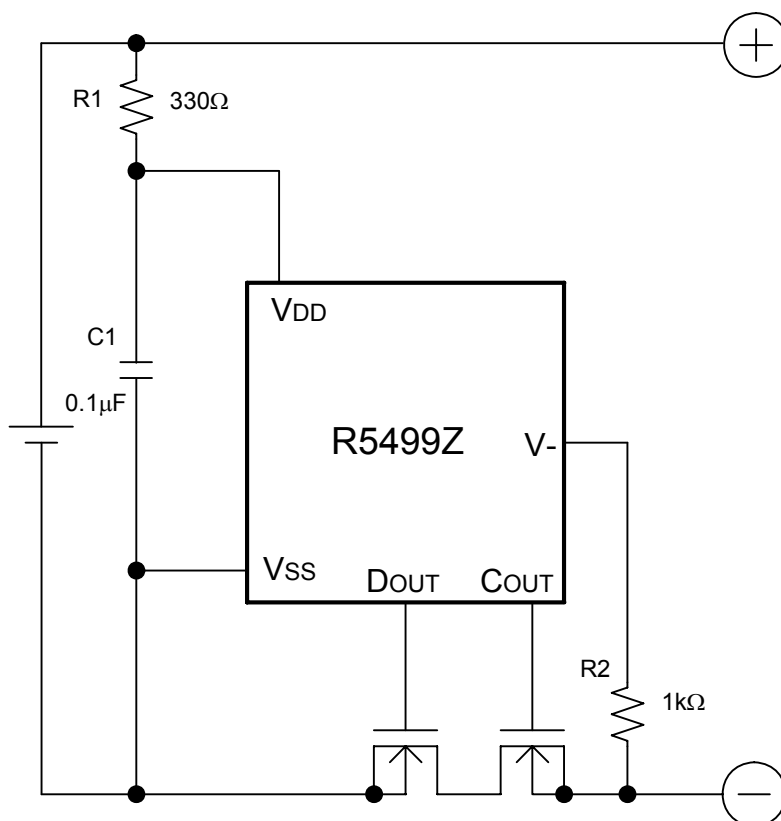
Mark Specification



①②: Series Code Name ... **XX**

③④: Lot Number (Alphanumeric serial number)

Technical Notes



*R1 and C1 stabilize a supply voltage to the R5499. A recommended R1 value is less than 1k Ω . A large value of R1 makes detection voltage shift higher because of conduction current flowed in the R5499.

Further, to stabilize the operation of R5499, use the C1 with the value of 0.01 μ F or more.

*R1 and R2 can operate as a current limit against setting cell reverse direction or applying excess charge voltage to the R5499. While small value of R1 and R2 may cause over power dissipation rating of the R5499, therefore a total of "R1+R2" should be 1k Ω or more. Besides, if large value of R2 is set, release from over-discharge by connecting a charger might not be possible. Recommended R2 value is equal or less than 10k Ω .

The typical application circuit diagram is just an example. This circuit performance largely depends on the PCB layout and external components. In the actual application, fully evaluation is necessary.

Over-voltage and the over current beyond the absolute maximum rating should not be forced to the protection IC and external components.

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 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.



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.

<http://www.e-devices.ricoh.co.jp/en/>

Sales & Support Offices

RICOH ELECTRONIC DEVICES CO., LTD.

Higashi-Shinagawa Office (International Sales)
3-32-3, Higashi-Shinagawa, Shinagawa-ku, Tokyo 140-8655, Japan
Phone: +81-3-5479-2857 Fax: +81-3-5479-0502

RICOH EUROPE (NETHERLANDS) B.V.

Semiconductor Support Centre
Prof. W.H. Keesomlaan 1, 1183 DJ Amstelveen, The Netherlands
Phone: +31-20-5474-309

RICOH INTERNATIONAL B.V. - German Branch

Semiconductor Sales and Support Centre
Oberrather Strasse 6, 40472 Düsseldorf, Germany
Phone: +49-211-6546-0

RICOH ELECTRONIC DEVICES KOREA CO., LTD.

3F, Haesung Bldg, 504, Teheran-ro, Gangnam-gu, Seoul, 135-725, Korea
Phone: +82-2-2135-5700 Fax: +82-2-2051-5713

RICOH ELECTRONIC DEVICES SHANGHAI CO., LTD.

Room 403, No.2 Building, No.690 Bibo Road, Pu Dong New District, Shanghai 201203, People's Republic of China
Phone: +86-21-5027-3200 Fax: +86-21-5027-3299

RICOH ELECTRONIC DEVICES CO., LTD.

Taipei office
Room 109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan (R.O.C.)
Phone: +886-2-2313-1621/1622 Fax: +886-2-2313-1623